

CI226218

400 models, 9 Teams, 1 coordination: BIM at work

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Learning Objectives

- Identify the benefits / advantages of adopting the BIM360 cloud technology for all stakeholders throughout the entire process
- Discover how the BIM360 workflow allows for faster process
- Identify how to implement a unified workflow with many actors around the world
- Learn how to overcome surplus of emails and exchange files with more effective communication and coordination

Description

How to coordinate people around the world in a project of 3.250.655m³, divided into more than 400 multi-disciplinary Revit models? This class will show how 3D coordination is possible in an effective way using Collaboration for Revit and BIM360 TEAM. The Red Line North Underground project in Doha was started with the use of many different local systems (Revit servers) and a central storage useful for exchanging models and information.

The adoption of the BIM360 platform allowed us to optimize the workflows saving time and money. With the integrated cooperation and collaboration made possible by the platform efficiency was maximized, therefore providing a solid base for decision-making process. Thanks to BIM360 all members of the team were able to share information and collaborate regardless where they were physically located, capitalizing from contributions, skills and intuitions of all team members in a smooth and simple way.

Speakers

Marcella Faraone

Marcella Faraone currently works in Italferr. She is responsible for researching new technologies and innovating workflows with BIM and GIS. She has a BIM management experience with a deep knowledge of BIM concepts, BIM delivery methods, BIM uses. Her work focus mainly on Design phase and construction follow up of the railway infrastructure projects (core business of Italferr). Marcella acquired this vast experience in the Red Line North Underground project in Doha, where she has worked from 2014 as MEP BIM Coordinator of the designers Joint Venture. This project has played a crucial part in the professional life of Marcella. It was the first time she had the occasion of working in an international and multicultural project. This was also a great improvement from a personal point of view. She is a firm believer in BIM methodology, so much that, in 2012 she promoted the introduction of BIM in her company and started pilot project with a group of designers. The project was successful and, from that moment on, BIM has widely adopted by Italferr. Before starting to work with BIM, she took part in several ICT projects as a Project Managers. During this years Marcella acquired experience in Information Management and GIS platform and awareness of great potentiality of GIS analysis. In the last year Marcella has focused her attention in particular on GIS and BIM data integration. She participated as a speaker at ESRI Italia conference 2018 and she won the “Smart Infrastructure 2018” award.

Marcella has great interests in science and especially in physics. She enjoys sharing this interest with her lovely 9 years old daughter during her free time by reading her related topics and conducting simple experiments.

Stefano Libianchi

Stefano Libianchi is a BIM Expert in the department of strategy, Innovation and System in Italferr, a company belonging to the Italian State Railways Group Ferrovie dello Stato Italiano. He participates in the researching of new technologies and innovating workflows with BIM and GIS.

He worked as Freelance BIM Technical Consultant with Autodesk from 2015 to 2018. During this years Stefano acquired experience in BIM management and delivery methods working as BIM Coordinator in the Red Line North Underground's project in Doha. Before the Doha project he worked as Architect in different projects.

Introduction

Italferr

Italferr is a company belonging to the Italian Railways Group Ferrovie dello Stato and has 34 years of experience in large infrastructures projects such as conventional and high speed rails, underground, stations and tramway lines.

Our expertise ranges from Project Management to Construction Site Management, Concept and detailed design to testing and commissioning of railway lines, Innovation solutions and Research to Integration Systems handling, etc.

At present, we are managing almost 1000 projects, and among these are 130 construction projects in Italy and abroad.

The main projects in Italy are high speed rail, high capacity and corridors design and construction.



The corridors (TEN-T project)

Italferr has been involved in reorganization design of railways, metropolitan, nodes in major Italian cities (Roma, Milano, Torino, Bologna, Firenze and Napoli) and Technology innovation of conventional rails.

The main activities of Italferr abroad are Feasibility studies, Detailed Design, Technology Innovation, Consultancy work, etc.

The Competence Center BIM-GIS

The Competence BIM GIS is a team inside the strategy and innovation officer under IT Department.

We have been supporting the introduction of BIM in Italferr since 2013, and in the last 5 years, we have worked as BIM manager and BIM coordinator in the Red Line North Underground project in Doha. At present, the main objective of the competence center is the research of new technologies in order to improve the processes and the workflow of engineering design, construction site management, testing activity and handover.

The project - Red Line North Underground project in Doha

Companies involved, organization and roles



Since June 2013, Italferr has been engaged in developing a detailed design for the Red line of the Doha underground railway linking the city's new international airport (NDIA) in the West Bay Area with the city centre. Italferr is the designing entity in a joint venture with Cowi and Oneworks.

Since January 2014, Italferr has been involved in designing MEP (Mechanical Electrical and Plumbing) for stations, tunnels (including underpasses and overpasses) and Emergency Exits. All this works has been designed entirely with BIM methodology.

Italferr's duties included the Design of the Alignment, Design Management and Coordination, Delivery Management, MEP BIM Coordination.

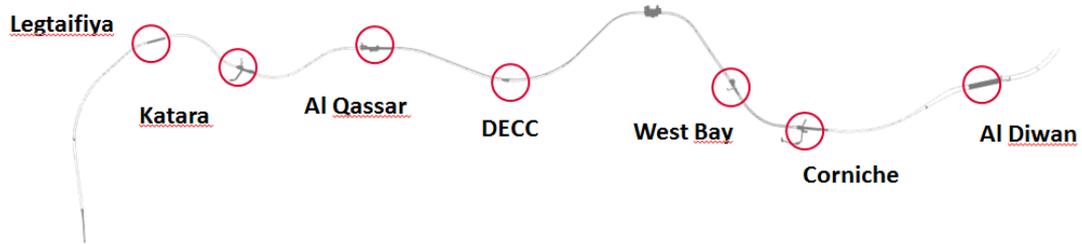
This was the first large linear infrastructure project undertaken by Italferr entirely designed in BIM after the BIM introduction project in Italferr and a small project regarding the detailed design of buildings in Firenze

Project details

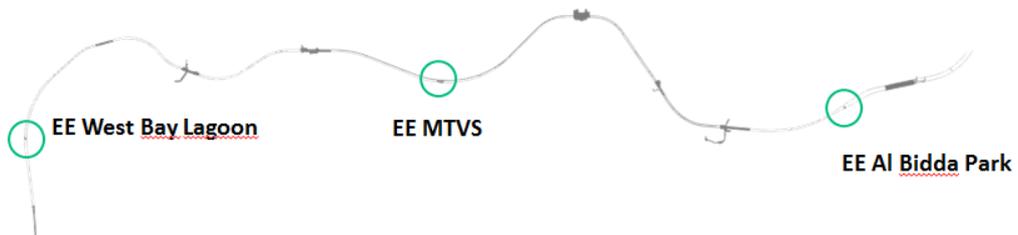
Activities include the completion of the civil works, the implementation of the technology systems and installations, the development of maintenance facilities for the Red Line North.

The project consist in:

n. 7 Stations Al Diwan, Corniche, West Bay, Doha Exhibition and Convention Centre, Al Qassar, Katara, Legtaifiya



n. 3 Emergency Evit MEP Al Bidda Park, MTVS, West Bay Lagoon



n. 6 Underpass: Al Diwan, Corniche, Doha Exhibition and Convention Centre, Al Qassar, Katara East, Katara West,

n. 3 Switchbox: Al Diwan, Corniche, Al Qassar

n. 1 Overpass: West Bay

n. 8 Stretches

The history of the Project – The Collaboration

In the following we will tell the history of the project from the beginning to nowadays focusing our attention on the Collaboration.

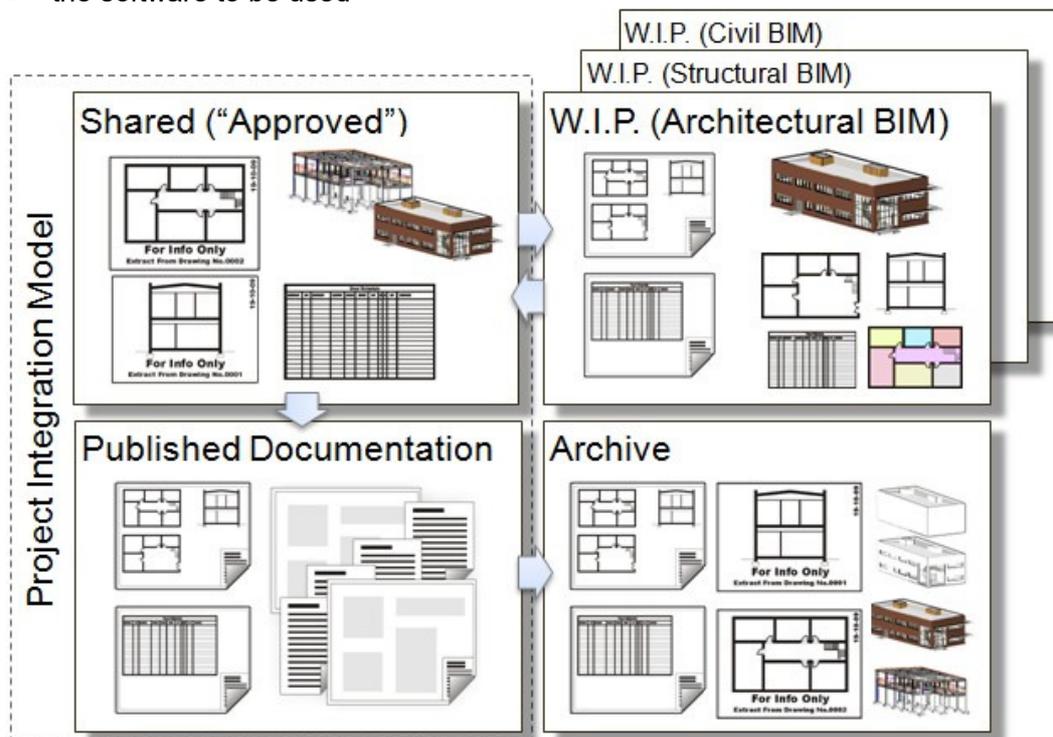
Chapter 1 – Entropy

A first structured approach

At the beginning our approach was really structured. A BIM Team was set up to build up a BIM process. After several days of discussion with all the stakeholders, the outcome was a BIM Execution Plan and a BIM Guideline for each discipline. The main topics discussed and written were:

the technological environment:

- The Common Data Environment: Projectwise has been chosen as the CIO the Common Data Environment according to BS1192
- the software to be used

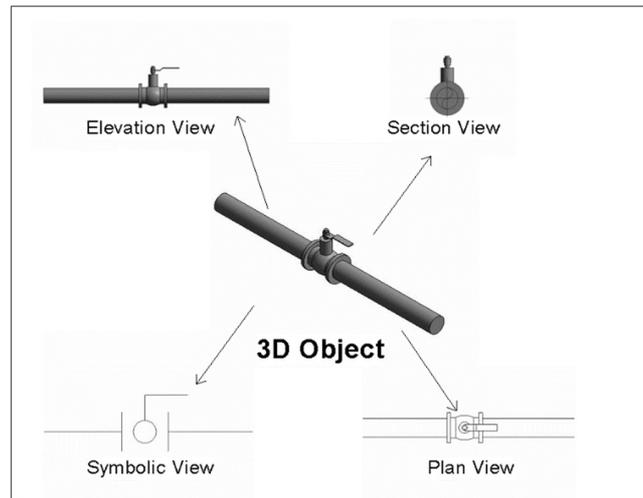


ProjectWise workflow for the models according to BS1192

The Organisation Chart of the BIM Team and the way the members reported in the according to Project Organization chart.

The level of detail of the model:

What elements shall be placed in the model, when those elements are to be placed in the model and to what level of detail those elements shall be represented (refer to QRBG Qatar Rail BIM Guidelines).



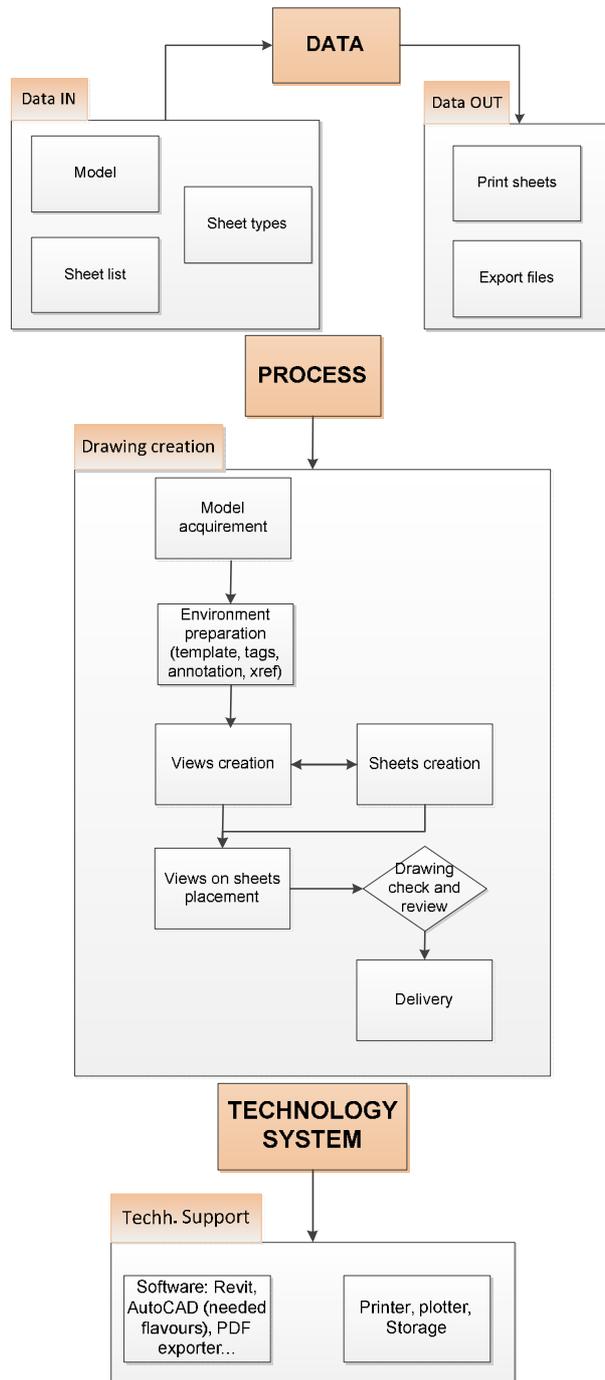
Model Element / Object - Example

A complete description of a single BIM uses:

- Model Authoring
- Drawing Production
- Design review and Quality check
- Clash detection
- Model element scheduling
- 4D sequencing
- BOM/BOQ

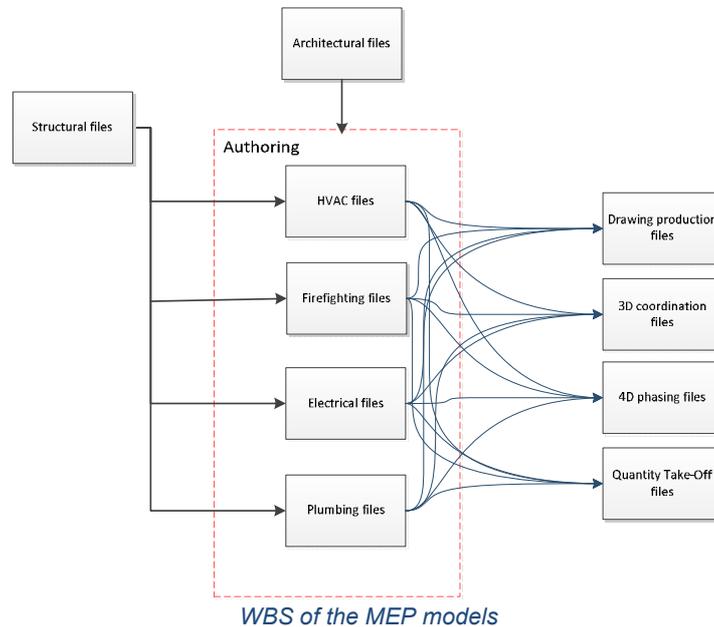
DATA	Key role	Description	Note
Input	BIM Coordinator	Revit models produced for Package 1 submission.	
Output	BIM coordinator Modeller	export files in DWG 2013, PDF	
PROCESS	Key role	Description	Note
Data acquirement	BIM Coordinator	BIM coordinator acquires the Revit models produced for the design stages.	
Data validation	Designer BIM coordinator	Models are checked to verify they can be used to produce technical drawings or need further specifications/modeling.	
Data preparation	BIM Modeler	Inside discipline models views and sheets for drawing production is set up Non discipline models are linked as external references.	
BIM model development	BIM Modeler	The model to be created is composed of: discipline 3D objects of elements, views (both models and drafting), section boxes, sheets. Each view will be properly annotated using the typical Revit tools (dimensions, texts, labels). Schedules will be placed on sheets if available (see specific BIM Use).	
Model correction	BIM Modeler	If corrections are required, models will be suitably modified following BIM coordinator guidance. After that, they are submitted again for review and approval.	
Specific content development	BIM Modeler	The specific typical content to be used: Title Block, Annotations, Text types, Dimension types, Type of Views.	
Final validation	Design manager	CIO Design Manager is responsible for the validation before the delivery to ISG;	
Delivery	Design Manager BIM Coordinator	CIO Design Managers are the final responsible for the drawings delivery and their validation while BIM coordinators are responsible for the process followed during the production.	
TECHNOLOGY SYSTEM	Key role	Description	Note
Software		Revit	

Drawing production BIM use



Process: Cross-Functional Flow Chart (Swim Lane Diagram)

The organization of MEP models structured as a WBS:



Description of the setup of the templates for MEP models (define shared parameters, codes, ect.)

Chapter 1 The entropy

There were 9 teams abroad.

1 CDE (ProjectWise) used to store all project data (basis, drawings, models, technical specifications) but obviously not used to collaborate with revit.

So each of the team had its own server for Revit Collaboration (mainly shared folders)

In order to collaborate among the disciplines (architectural, Structure and MEP) the exchange of files were made using the CDE, WE, emails, etc. The results was a great confusion. We really didn't know which were the correct revisions of the models to be used. This produced uncoordinate federal models.

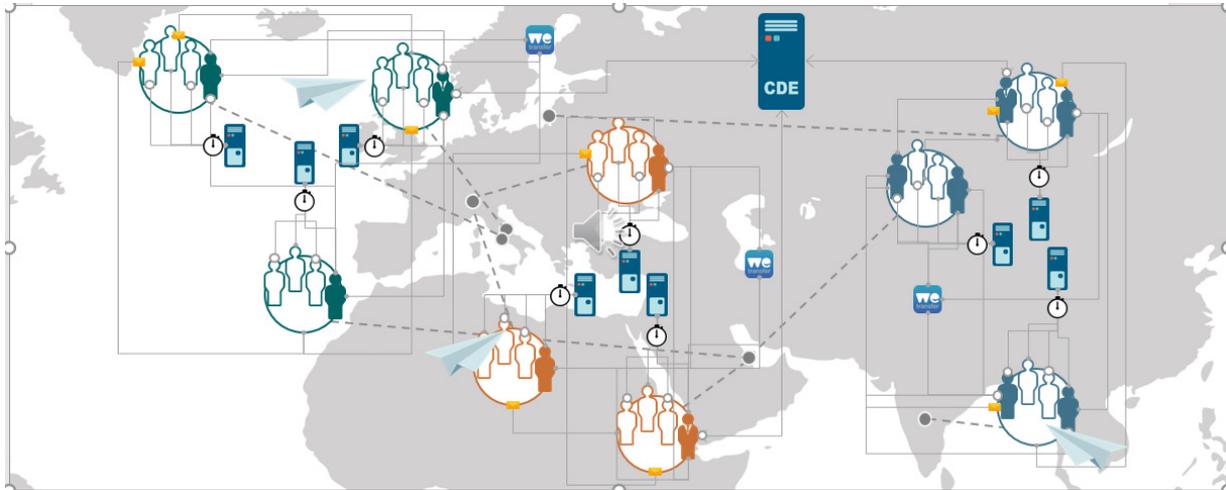
A long span of time was lost by the BIM Coordinators to produce packages to store models in the CDE, or to share a model with the other teams.

There were several reworks of the same packages due to the use of a wrong versions of the models of the other disciplines.

So, despite of our approach there was a real entropy.

The non-scientific definition of the Entropy is: a measure of the uncertainty of an outcome.

This represent the real situation.

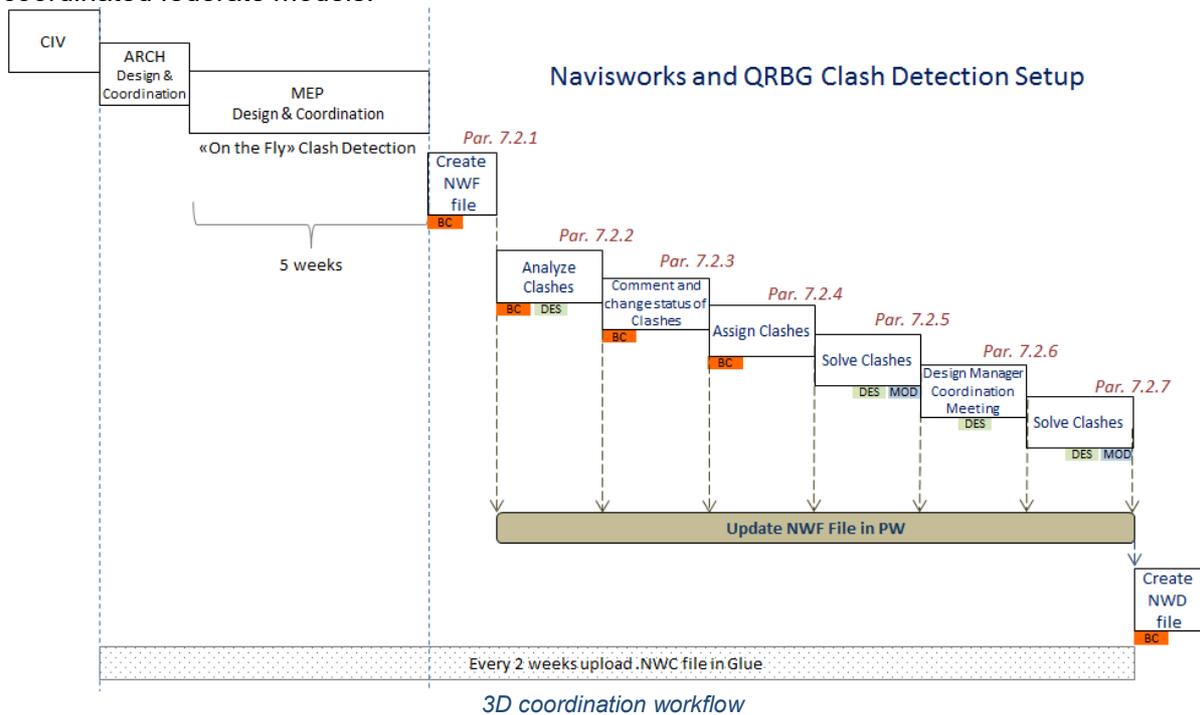


Distribution of the teams and the servers abroad

Chapter 2 - Roll up the sleeves

3D coordination process: a better coordination between the teams

After 3 days of meeting in Doha with the BIM Team and the other members of the staff involved in the process, a complete process of coordination was built up, to ensure as a final outcome coordinated federate models.



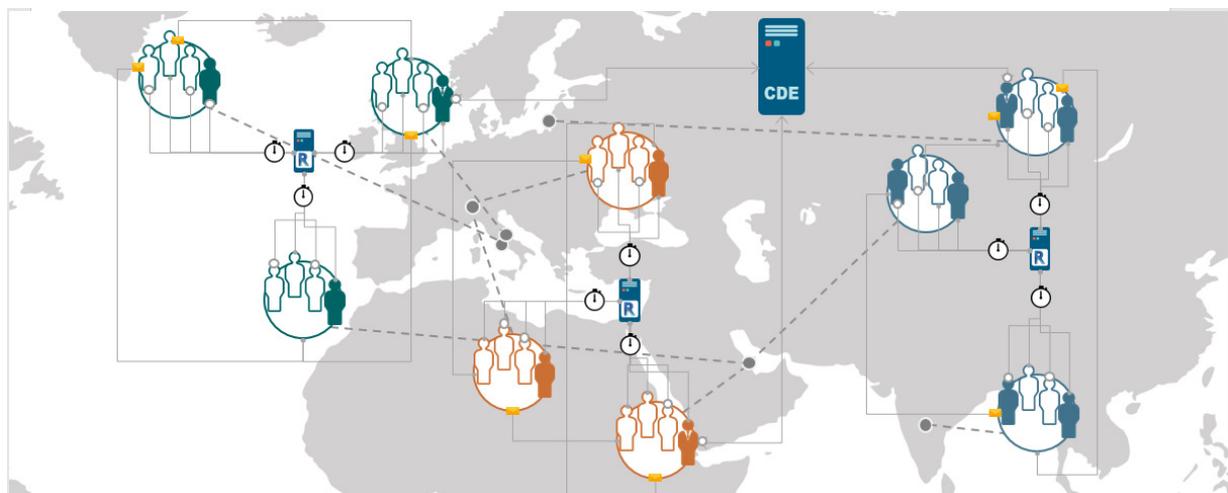
The introduction of Revit Server

We set up a Revit Server for each team and established that the CDE should be the only way to share the models.

In this way we cutted the redundancy and the rework of the same packages

Still technology wasn't ready and couldn't help us to find a better way to collaborate

We immediately noticed the improvement by using Revit Server: In fact while growing the models version, the number of clashes was reducing And at the same time even the time spent to coordination has been reduced of about 20 per cent in compare of first part of the project working with only one server for company, reduce the possibility of losing data and works, so the work of BIM Coordinator was simplified but not enough



New configuration of servers abroad

Chapter 3 - Order with BIM 360 Team and C4R

At the end of the first part of the project when the detailed design of all stations was submitted A second part of the project started with minors works such as emergency exits, underpasses, tunnels.

So, the works were minor but the number of the models grew up exponentially and the coordination of all these works with the stations increased the difficult of the BIM Coordinators Despite this the technology finally started to support us with the BIM Team360 and C4R.

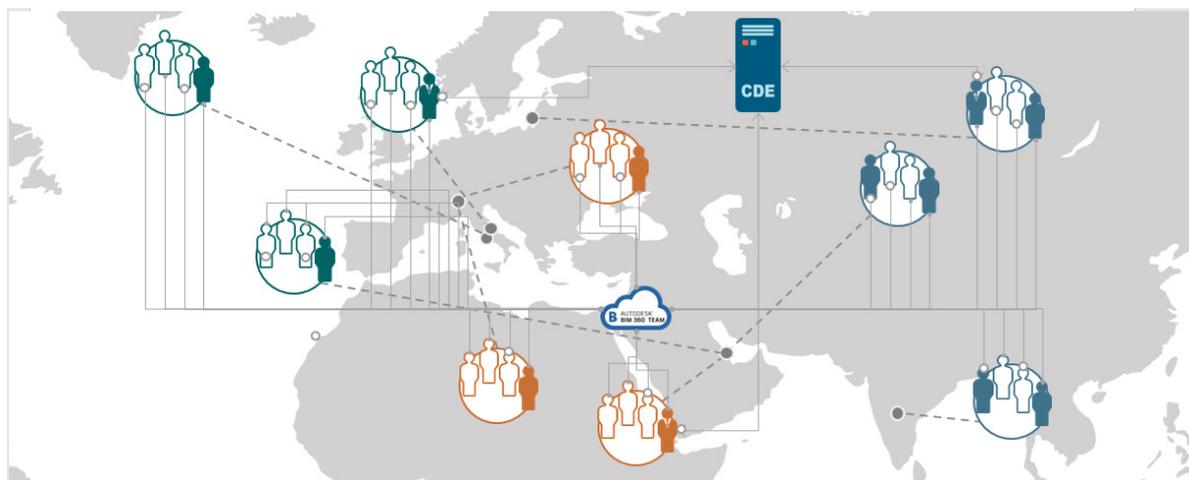
The screenshot shows the BIM 360 Team interface for a project named 'Team Italferr.C4R'. It features a navigation bar with filters like 'PINNED', 'ALL', 'OWNED BY ME', and 'SHARED WITH ME', along with a 'Create Project' button. A table lists various project components with columns for Name, Created By, and Created On. An activity feed on the right shows recent uploads and user additions.

Name	Created By	Created On
Admin Project		Apr 19, 2017
Al Bidda (Al Diwan)	Marcella Faraone	May 30, 2017
Al Bidda Park	Marcella Faraone	Jun 27, 2017
Al Qassar (Al Whada)	Marcella Faraone	May 30, 2017
Corniche (Al Bidda)	Stefano Libianchi	May 30, 2017
Dataset	Marcella Faraone	Apr 19, 2017
DECC (West Bay Central)	Marcella Faraone	Apr 19, 2017

Set up of the environment in BIM360 Team

The introduction of BIM360 Team

The CDE remained only to exchange official revisions, but every team could work simultaneously on BIM 360 Team with C4R.



An easier way to work

Look at the figures

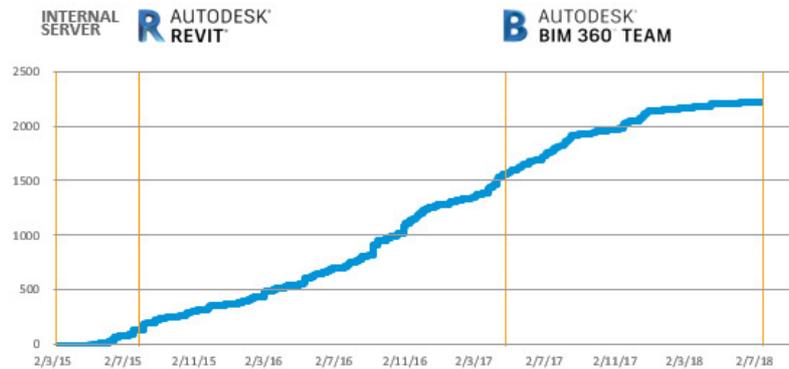
In the following we will look at the figures representative of the trend of the project. We have compared the numbers of official revisions, submitted in different stages of the project, with the number of clashes and the hours spent by the different members of the BIM Team.

Time axis have been divided into three different the three different stages characterize by the different ways of collaboration described previously:

- Collaboration with internal servers for each teams
- Collaboration with Revit Server
- Collaboration with BIM360 Team and C4R

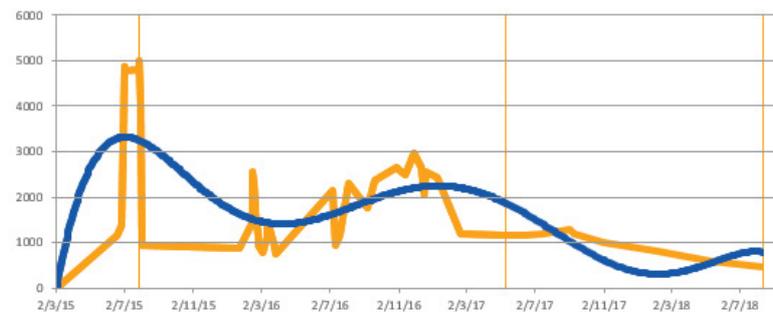
The graphics show how the number of the clashes and the hours spent by the BIM Team for coordination, dramatically decrease with the use of an effective instrument of collaboration. Another point of attention is the decrease of emails regarding 3D coordination, exchange of models and design review due to an improvement of communication in BIM360 Team.

NUMBER OF MODELS VERSIONS



2250

NUMBER CLASHES



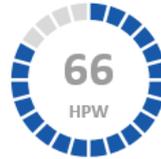
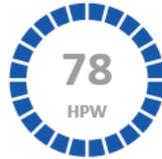
600

INTERNAL
SERVER

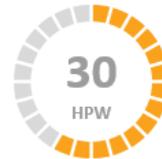
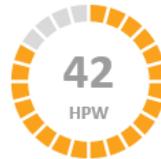
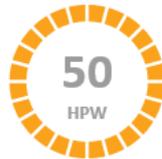
R AUTODESK®
REVIT®

B AUTODESK®
BIM 360™ TEAM

COORDINATION

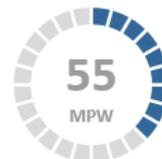


BIM SPECIALIST



Number of hours spent by BIM Team

MAIL



Number of emails

The sources of figures

Number of the models

The numbers of the official revision submitted were extracted from the shared folder of the CDE ProjectWise through an export in excel.

The image shows a ProjectWise Explorer window displaying a list of files with columns for Name, Description, Version, File Updated, Created, File Name, File Revision, and Project. Below the Explorer is an Excel spreadsheet with a line graph titled "Models Number". The graph plots the number of models (Y-axis, 0 to 2500) against dates (X-axis, from 01/07/2015 to 01/07/2018). Two data series are shown: "Series1" (blue line) and "Series2" (red line). A callout box points to a specific data point on Series1 with the text "Serial Parto 10/09/2016 Value 855".

File Name	Description	Version	File Updated	Created	File Name	File Revision	Project
M001-SG-MHV-MD3-RNSTLUP-ZZ-70511.rvt	Luola Malina/The Peat Station, District Cooling Pip...	2.3	05/04/2017 14:23:52	15/11/2015 11:25:45	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70511.rvt	Luola Malina/The Peat Station, District Cooling Pip...	2	25/12/2016 16:53:52	15/11/2015 11:25:45	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, D01-DO2-MJ-MJ...	2.6	20/12/2017 16:53:55	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, D01-DO2-MJ-MJ...	2.4	21/08/2017 13:44:17	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, D01-DO2-MJ-MJ...	2.3	07/07/2017 17:33:01	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, D01-DO2-MJ-MJ...	2.2	20/05/2017 17:30:22	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, D01-DO2-MJ-MJ...	2.05	21/03/2017 16:34:25	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, D01-DO2-MJ-MJ...	2.6	24/02/2017 17:36:19	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, D01-DO2-MJ-MJ...	2.05	11/08/2015 16:55:15	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTLUP-ZZ-70674.rvt	Luola Malina/The Peat Station, HVAC Model		11/08/2015 11:48:52	11/08/2015 11:48:43	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.2	28/06/2017 16:29:48	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.2A	13/06/2017 19:06:11	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.2	04/04/2017 12:05:44	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.0	01/01/2017 13:16:14	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.0	22/10/2016 15:58:58	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.0	24/10/2016 12:30:50	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.0	08/09/2016 13:21:08	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By Central Station, D01-DO2-MJ-MJ, HVAC...	2.0A1	04/07/2016 13:17:27	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	M001-SG-MHV-MD3-RNSTWBC-ZZ-70625 - West B...	IM Rev. A	06/05/2016 18:44:24	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	M001-SG-MHV-MD3-RNSTWBC-ZZ-70625 - West B...	2	28/02/2016 18:00:57	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	M001-SG-MHV-MD3-RNSTWBC-ZZ-70625 - West B...	1.1	18/12/2015 13:14:36	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	M001-SG-MHV-MD3-RNSTWBC-ZZ-70625 - West B...	0.1	28/07/2015 12:08:24	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	M001-SG-MHV-MD3-RNSTWBC-ZZ-70625 - West B...	1.1	28/07/2015 12:08:24	28/07/2015 12:07:56	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-82027.rvt	West By Central, Pedestrian Underpass, HVAC Model	1.1	09/11/2017 16:38:13	12/05/2017 19:34:50	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-82027.rvt	West By Central, Pedestrian Underpass, HVAC Model	2.0	09/08/2017 15:27:03	12/05/2017 19:34:50	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-82027.rvt	West By Central, Pedestrian Underpass, HVAC Model	1.1	12/05/2017 19:34:55	12/05/2017 19:34:50	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By South Station, MD-N4, HVAC Model	2.3	20/12/2017 16:52:07	24/08/2015 16:21:01	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By South Station, MD-N4, HVAC Model	2.4	04/08/2017 11:14:14	24/08/2015 16:21:01	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By South Station, MD-N4, HVAC Model	2.3A	28/07/2017 18:26:52	24/08/2015 16:21:01	M001-SG-MHV-MD3-R...		
M001-SG-MHV-MD3-RNSTWBC-ZZ-70625.rvt	West By South Station, MD-N4, HVAC Model	2.2	27/05/2017 18:36:30	24/08/2015 16:21:01	M001-SG-MHV-MD3-R...		

Example of export from ProjectWise of all official submitted versions

Number of clashes

During the Project, the client requested for a feedback of the coordination process for each station and for each minor work. The clash detection made with Autodesk Navisworks should be updated and submitted every 2 weeks according to Coordination Process. These files should be updated every 2-3 days in the run-up to the submission.

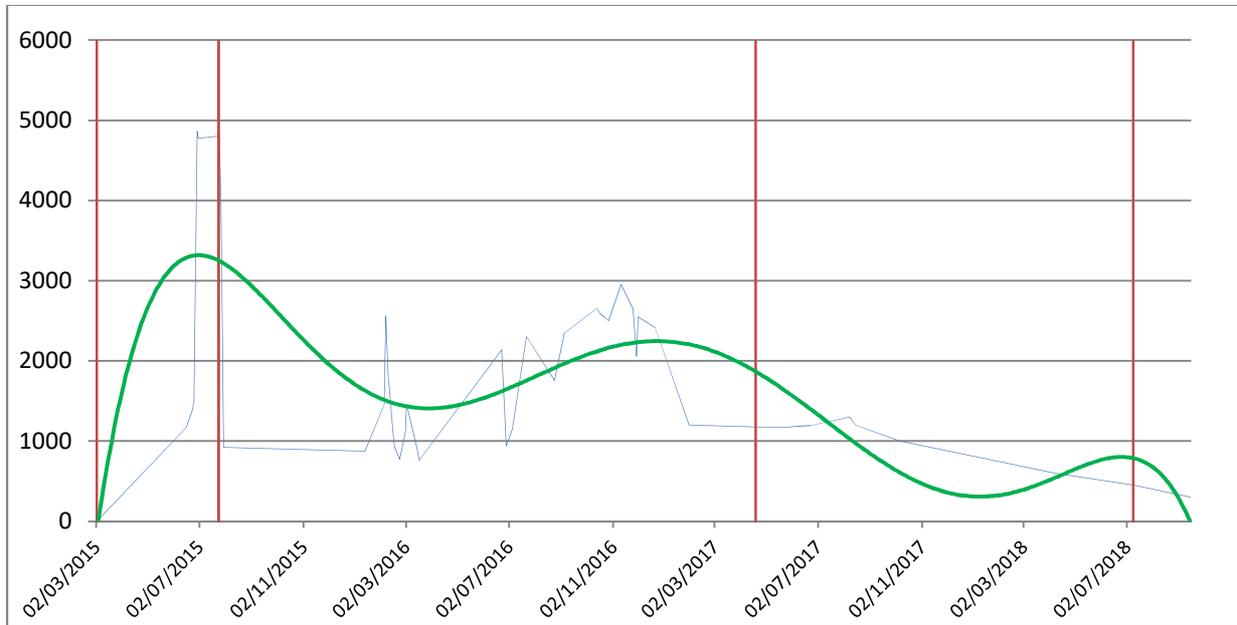
But the Navisworks files were not understandable to the top management and other non-technical members of the project staff.

So, in order to give them the progress of coordination process, we extracted from Navisworks the summary of clashes in an excel file as shown in the picture below.

CIV - MEP	
CIV-ELE	
018_STR//STR+MEC+ELEC_AA_Slabs	28
020_STR//STR+MEC+ELEC_AA_Bearing Walls	41
	69
CIV-ELE-INCHARGETOCIV	
019_STR//STR+MEC+ELEC_AA_Framing	2
	2
CIV-ELE_OPENINGS	
020_STR//STR+MEC+ELEC_AA_Bearing Walls	27
069_STR//STR+MEC+ELEC_AB_Slabs	5
	32
CIV-ELE_OPENINGSBELOW300X300	
020_STR//STR+MEC+ELEC_AA_Bearing Walls	24
071_STR//STR+MEC+ELEC_AB_Bearing Walls	41
	65
CIV-FRS_OPENINGS	
020_STR//STR+MEC+ELEC_AA_Bearing Walls	70
024_STR//STR+MEC+ELEC_AA_Vertical Transportation & Circulation	28
	98
CIV-FRS_OPENINGSBELOW300X300	
020_STR//STR+MEC+ELEC_AA_Bearing Walls	54
178_STR//STR+MEC+ELEC_AC_Bearing Walls	4
	58
CIV-MHV_OPENINGS	
176_STR//STR+MEC+ELEC_AC_Slabs	9
	9
CIV-MHV_OPENINGSBELOW300X300	
020_STR//STR+MEC+ELEC_AA_Bearing Walls	81
178_STR//STR+MEC+ELEC_AC_Bearing Walls	11
	92

Example of Clash Report in Excel

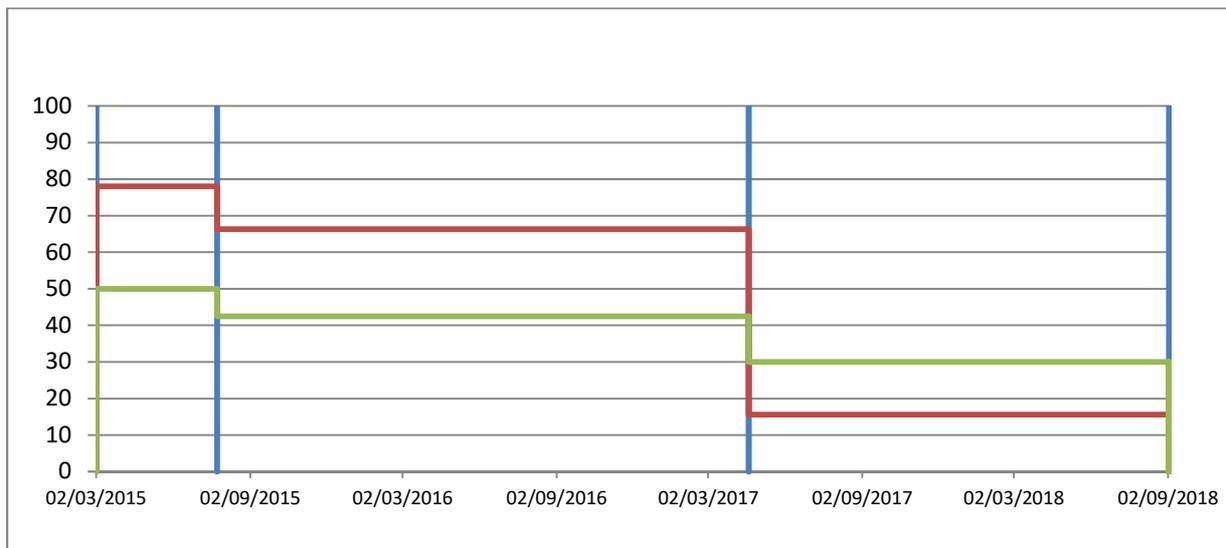
The elaboration of these reports, made with an interpolation of the number of clashes during the entire span of time of the project, gives the results shown in the picture below.



Interpolation of the number of clashes during the span of time of the project

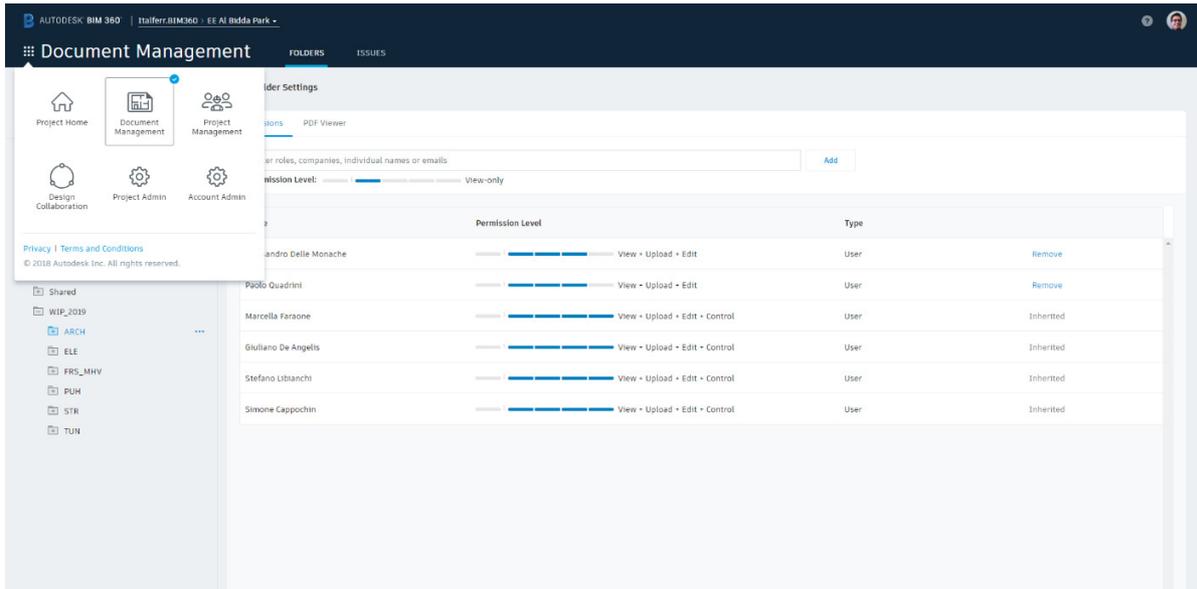
Hours spent by the BIM Team for coordination

We calculate the hours charged from the BIM Team on the project at closure (data available in the company database)

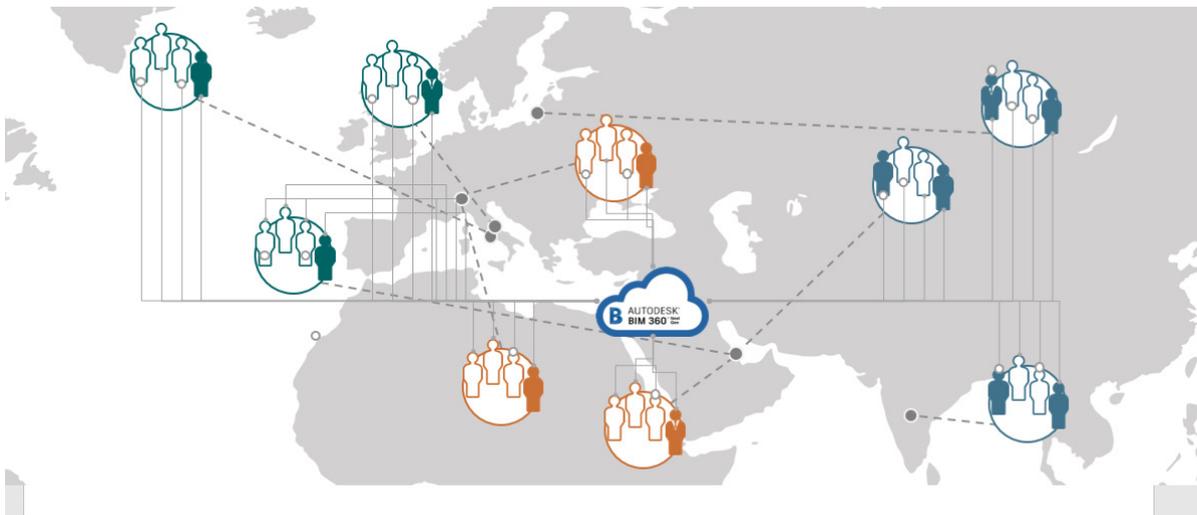


Epilogue - At present: BIM 360 Next Gen

At present we are approaching the BIM 360 nextgen for some new little projects. As experimental introduction to this platform, we choose to set up the environment of one minor work of RLNU, the Emergency Exit AI Bidda Park, to simulate what could have been the trend of the project, if we had used BIM 360 next gen.



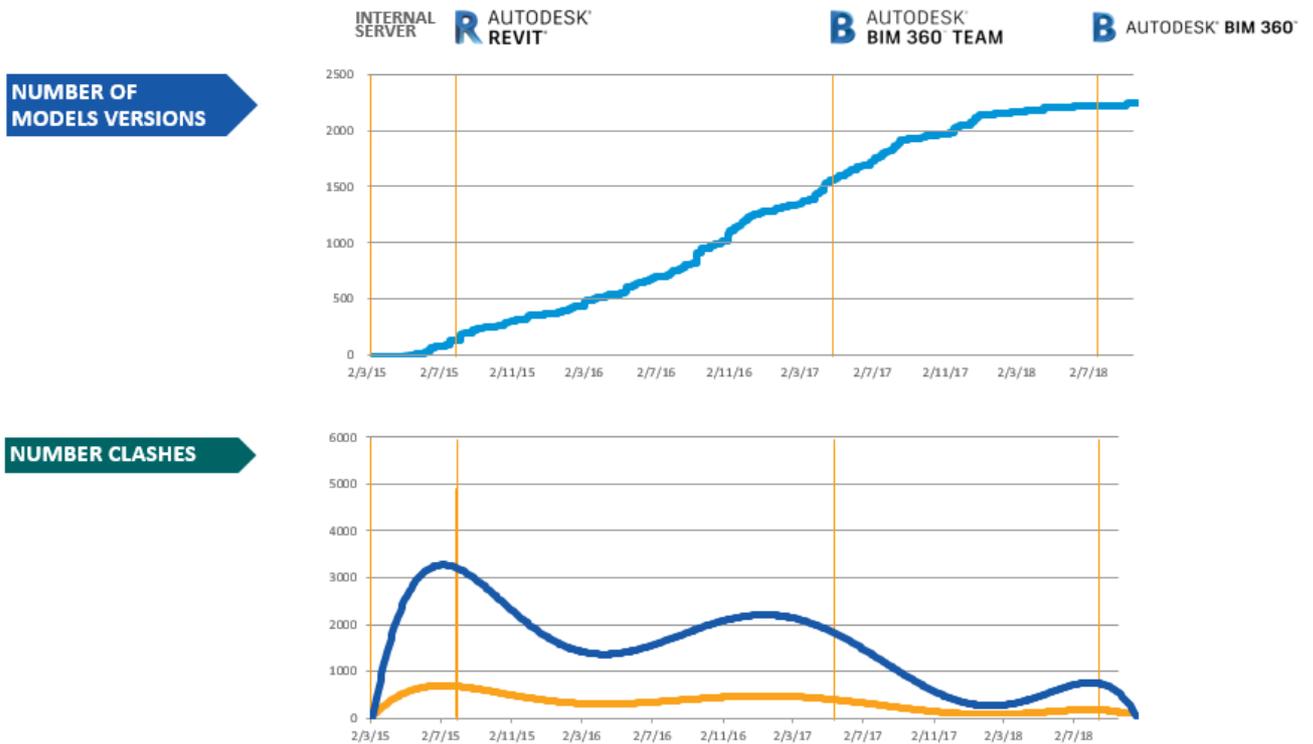
Set up of the environment of the Emergency Exits AI Bidda Park

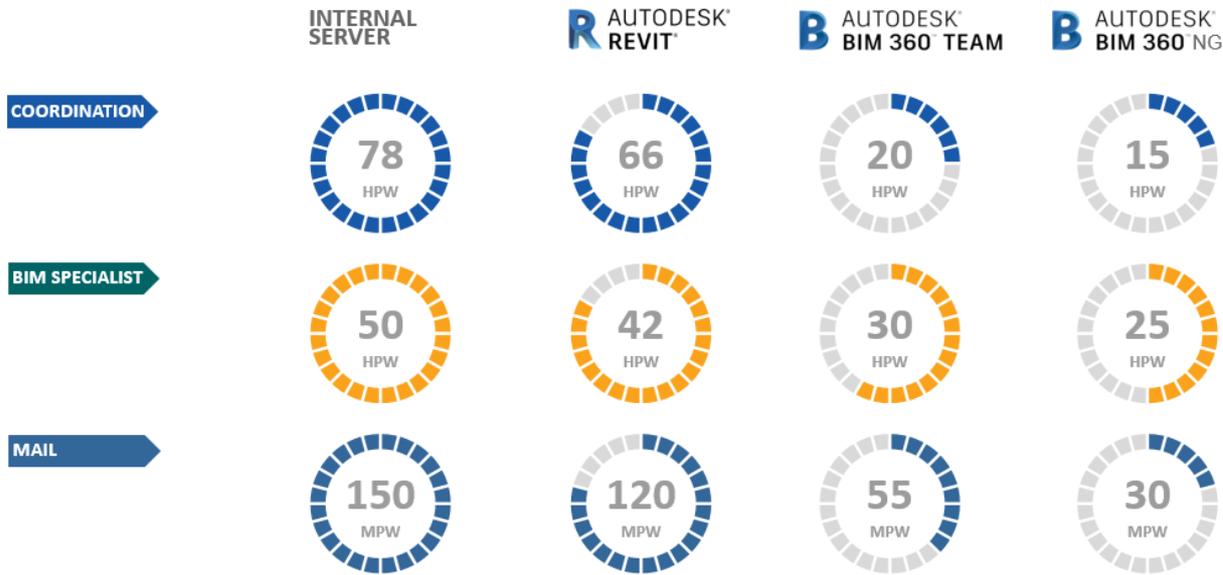


Hypothetical configuration of the RLNU with BIM360 NG

Look at the figures

In the following we will explain our hypothesis, simulating the figures. We think that, the structured approach like the ones built up by Italferr and the other teams of the Joint Venture, together with the use of BIM360 netxgen, could help us to save time and money in a large infrastructure project like the Red Line North Underground in Doha.





Comparison between Revit Server, BIM360 Team/C4R, BIM360 NextGen

In the following we will show a comparison between the 2 main platform used during the RLNU project and BIM 360 Next Gen, in order to justify the figures shown previously.

The comparison will be done following 3 BIM uses and describing every single action on the platform to be done by the responsible members of the team.

Design Review

DATA	Key role	Description	Revit Server	BIM360	BIM360 NextGen
Input	BIM Coordinator	Authored Models to be periodically submitted and reviewed. All involved disciplines BIM coordinator have to upload the models to the specific WIP area for model and design review.	Models stored in the shared folder of CDE and Models in own Revit Server	Models stored in BIM360 Team	Models stored in BIM360 Docs
Output	BIM Coordinator	Reports, annotated drawings, schedules are the typical output of a design/model review process. BIM coordinators and Design Managers are the responsible for checking and reporting the issues for correction to the authoring team.	Reports, annotated drawings, schedules sent via emails or uploaded in CDE	Reports, annotated drawings, schedules inside BIM360 Platform and sent via emails	Issues workflow in Docs

PROCESS	Key role	Description			
Data acquirement	BIM Coordinator	BIM coordinators have to check models produced by their own authoring team by taking authored models from the adopted EDMS platform.	<ul style="list-style-type: none"> - Open from the browser Revit Server Administrator (specifying the Server name in the URL) - Delete the file to be updated - Open the Revit file - Create the central model - Save in the Server - Open the files containing the updated model and reload this 	Open the project in BIM360 Team	Open the project in BIM 360 Design Collaboration The use of BIM 360 Design Collaboration assure us that the revision of the models are the correct ones (only the ones "Consumed")
Data validation	BIM Coordinator	Last revision/version of file is to be checked, BIM coordinators to ensure this point.	The BIM Coordinators assure that the revision stored in shared area of the CDE is the correct revision to be used	The Bim Coordinators assure that the revision stored in BIM 360 Team is the correct revision to be used compare this with the official revision stored in shared area of the CDE	The BIM Coordinator assure that all models have been consumed with the correct revisions
Data preparation	BIM Coordinator ; BIM specialist	Models have to be used <i>as-is</i> or exported to pdf or NWC file formats. The specific BCF file has to be loaded in Autodesk Model Review for model consistency checking.	The models, the drawings, the reports, ect. must be exported from Revit Server and uploaded in the shared area of CDE. Models must be published on Glue	The models, the drawings, the reports, ect. must be exported from BIM360 Team and uploaded in the shared area of CDE. Models must be published on Glue	The BIM coordinator create a new package with Design Collaboration , the drawings are extracted in Docs and a Clash detection is made with Model Coordination

Drawing Production

DATA	Key role	Description	Revit Server	BIM360 Team/C4R	BIM360 NextGen
Input	BIM Coordinator	Revit models produced for Package 1 submission.	Extractive Models stored in the shared folder of CDE and Models in own Revit Server	Models stored in BIM360 Team	Models stored in BIM360 Docs
Output	BIM coordinator, Modeller	export files in DWG 2013, PDF	The drawings are extracted from Revit models and uploaded in CDE	The drawings are extracted from Revit models and uploaded in CDE	The drawings are automatically extracted through Docs

PROCESS	Key role	Description			
Data acquirement	BIM Coordinator	BIM coordinator acquires the Revit models produced for the design stages.	Download models from shared area CDE and upload them in Revit Server	Open the project in BIM360 Team	Place the model in Docs (plans folder)
Data validation	Designer, BIM Coordinator	Models are checked to verify they can be used to produce technical drawings or need further specifications/modeling.	The BIM Coordinators assure that the revision stored in shared area of the CDE is the correct revision to be used. The Designers check the models	The Bim Coordinators assure that the revision stored in BIM 360 Team is the correct revision to be used compare this with the official revision stored in shared area of the CDE The Designers check the models	The BIM Coordinator assure that all models have been consumed with the correct revisions
Data preparation and model development	BIM Modeler	Inside discipline models views and sheets for drawing production is set up. The model to be created is composed of: discipline 3D objects of elements, views (both models and drafting), section boxes, sheets. Each view will be properly annotated using the typical Revit tools (dimensions, texts, labels). Schedules will be placed on sheets if available (see specific	Create sheet views in the models and upload the extracted pdf in shared area of the CDE	Create sheet views in the models and upload the extracted pdf in shared area of the CDE	Create sheet view in to the model and copy the models in Docs (plans folder)
Model correction	BIM Modeler	If corrections are required, models will be suitably modified following BIM coordinator guidance. After that, they are submitted again for	Change the models in Revit Server and/or upload the modified revisions exported from CDE	Change the models using the collaboration method, with BIM 360 Team/C4R	Change the models using the collaboration method, with BIM 360 NextGEN
Specific content development	BIM Modeler	The specific typical content to be used: Title Block, Annotations, Text types, Dimension types, Type of Views.	Open the file using the collaboration method, with Revit Server	Open the file using the collaboration method, with BIM 360 Team/C4R	Open the file using the collaboration method, with BIM 360 NextGEN
Final validation	Design manager	CIO Design Manager is responsible for the validation before the delivery to ISG;	<ul style="list-style-type: none"> - Print sheets; - Markup on the paper; - Scan the paper; - Sent PDF with emails or upload them in CDE 	Check Models with aBIM 360Team: <ul style="list-style-type: none"> - Mark - Issue or <ul style="list-style-type: none"> - Extract sheets in pdf format; - Sent PDF with emails or upload them in CDE for validation. 	Check Models with BIM 360 Document Management: <ul style="list-style-type: none"> - Compare; - Mark; - Issue.
Delivery	Design Manager	CIO Design Managers are the final responsible for the drawings delivery and their validation while BIM coordinators are responsible for the process followed during the production.	Upload pdf in shared area of CDE	Upload pdf in shared area of CDE	Create the package in BIM360 Docs

3D Coordination

DATA	Key role	Description	Revit Server	BIM360 Team/C4R	BIM360 Next Gen
Input	BIM Coordinator	Revit authored models produced for coordination;	Models stored in the shared folder of CDE and Models in own Revit Server	Models stored in BIM360 Team	Models stored in BIM360 Docs
Output	BIM Coordinators, Design Managers	Coordinated models, schedules, 2D drawings and imagery	Reports, models and nwd uploaded in CDE	Reports, models and nwd uploaded in CDE	Reports, models stored in BIM360 Docs and nwd uploaded in BIM360 Docs

PROCESS	Key role	Description			
Data acquirement	BIM Coordinators	BIM coordinator acquires the Revit models produced for	Download models from shared area CDE and upload them in Revit Server	Open the project in BIM360 Team	Open the project in BIM360
Data validation	Designer, Design Managers	Designated designers on behalf of the Design Manager, checks and states that the acquired models are updated for the 3D coordination purpose.	The BIM Coordinators assure that the revision stored in shared area of the CDE is the correct revision to be used. The Designers check the models	The Bim Coordinators assure that the revision stored in BIM 360 Team is the correct revision to be used compare this with the official revision stored in shared area of the CDE The Designers check the	The BIM Coordinator assure that all models have been consumed with the correct revisions
Data preparation	Designer, BIM modelers	Models are exported to NWC file format as per adopted guidelines.	Export the nwc file to a local folder and export models in Glue	Export the nwc file to a local folder and export models in Glue	Open 3D view in Model Coordination and/or export nwc file in a local folder
BIM development	BIM Coordinators	Models (NWC) are inserted in an NWF file;	Create a nwf file	Create a nwf file	Create a nwf file
Model review	CIO BIM Manager	BIM manager and Coordinators check the model, run clash tests (defined in 3.3.3.1). After that they assign the correction to specific stakeholders. Assigning and solutions are tracked inside the NWF file.	<ul style="list-style-type: none"> - Analyse and Assign the clashes - Export the report - Save nwf file - Upload Report and nwf files on CDE 	<ul style="list-style-type: none"> - Analyse and Assign the clashes - Export the report - Save nwf file - Upload Report and nwf files on CDE 	<ul style="list-style-type: none"> - Analyse the clashes on BIM 360 And/Or - Analyse and Assign the clashes - Export the report - Save nwf file - Upload Report and nwf files on CDE

V

PROCESS	Key role	Description			
Model correction	Designer, Modeller	Designer and BIM modelers updates the specific models they are responsible for, following the correction process and elements correction priority as per software guidelines. Then models are submitted again to the EDMS system.	Update the models	Update the models	- Open the Revit file; - Modify the models;
	BIM Coordinator		During the coordination process the models must be uploaded tin the WIP folder of the CDE At the end of the coordination process the models and nwd	During the coordination process update models. At the end of the coordination process the models and nwd must be uploaded tin the shared area of the CDE	During the coordination process update models. At the end of coordination process create a new package and/or update nwd file
Final validation	Design Managers	Design managers check each specific model and validate the technical and design result.	Check the models on Navisworks or Glue	Check the models in BIM360	Check the models in BIM360
Delivery	BIM Coordinators	Validated models are updated in the EDMS and shared for further elaboration.	- Open the Revit file; - Do the model review - At the end of the coordination save the Revit file locally without workset; - Delete the views; do the Purge ... - Upload the file to the CDE in the Shared folder.	- Open the Revit file; - Do the model review - At the end of the coordination save the Revit file locally without workset; - Delete the views; do the Purge ... - Upload the file to the CDE in the Shared folder.	Create the package after the Quality check

Conclusions

We have identified the benefits and advantages of adopting the BIM360 cloud technology for all stakeholders throughout the entire process and have shown how to implement a unified workflow with many actors around the world. These objectives have been achieved with the revision of the entire project from a collaboration point of view and with the demonstration of the hypothesis that a structured approach like the ones built up by Italferr and the other teams of the Joint Venture, together with the use of BIM360 netxgen, could help us to save time and money in a large infrastructure project like the Red Line North Underground in Doha.

In the same way we saw how BIM360 workflow allows for faster process with the comparison between Revit Server, BIM360 Team/C4R and BIM360 Next Gen and learn how to overcome surplus of emails and exchange files with more effective communication and coordination with the use of BIM360 workflows especially in terms of coordination, design review and drawing production.

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