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The ITER CODAC network design

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ABSTRACT

The ITER CODAC (Control, Data Access and Communication) system is the conventional central control system responsible for operating the ITER facility. CODAC Networks comprise Plant Operation Network (PON), Time Communication Network (TCN), Synchronous Databus Network (SDN) and Data Archiving Network (DAN). CODAC networks connect all plant systems to the central control system through one or more networks depending on the requirements of the plant system I&Cs. The CODAC network infrastructure has been defined including network topology, backbone cable and space allocation network equipment in different ITER plant buildings.

This paper presents the design of the current network infrastructure and the four functional networks. This paper also presents the implementation plan of the CODAC network according to the ITER project schedule.

1. Introduction

ITER (International Thermonuclear Experimental Reactor) is an international nuclear fusion research and engineering project, which is located at Cadarache in the South of France. ITER is an experimental tokamak nuclear fusion reactor, aiming to demonstrate the scientific and technical feasibility of fusion power.

The CODAC (Control, Data Access and Communication) system is the central control system for the conventional plant control systems of the ITER Instrument and Control (I&C) architecture as shown in Fig. 1. CODAC is responsible for coordinating and orchestrating the operation of the ITER devices.

CODAC communicates with plant systems over a set of segregated networks for different purposes [1–3]. CODAC Networks comprise Plant Operation Network (PON), Time Communication Network (TCN), Synchronous Databus Network (SDN) and Data archiving Network (DAN). The baseline performance requirements are the followings [3]:

- PON provides connections to ~200 Plant System I&C and ~2000 I&C cubicles.
- TCN provides time synchronization to clients better than 50 ns RMS accuracy.
- SDN provides a deterministic application-to-application network latency < 50 µs. The latency for network switch is < 2 µs.
- DAN provides data throughput up to 50 GB/s, and may grow with evolution of the ITER project.

Each plant system can communicate over one or more networks depending on the requirements.

The design of the ITER CODAC network is based on the performance requirements. Network redundancy, scalability and cost-efficiency are also key factors for the network design. Data center network technology provides a cost-efficient, high performance solution; hence it is adopted for the PON core layer, SDN and DAN. The data center network technology, Multi-chassis Link Aggregation (MLAG), is used for the above-mentioned network to improve redundancy. Industrial Ethernet devices are used for the PON aggregation and access layer due to the harsh environment conditions in the plants. Precision Time Protocol (PTP v2, IEEE-1588–2008) is used for TCN based on the performance requirement and device availability in the market.

2. ITER CODAC network design

2.1. Infrastructure

The CODAC network infrastructure provides connectivity to all plant control systems distributed in 28 buildings on the ITER site. The architecture as illustrated in Fig. 2, is based on a redundant dual star configuration, where the centers are located in Main Server Room (MSR) in Building 71 and Backup Server Room (BSR) in Building 24. The core layer network switches will be housed in MSR and BSR.

The aggregation layer network switches will be installed in the network cubicles in CODAC network hutches which are distributed over the ITER site. The network hutch is a dedicated room or area providing

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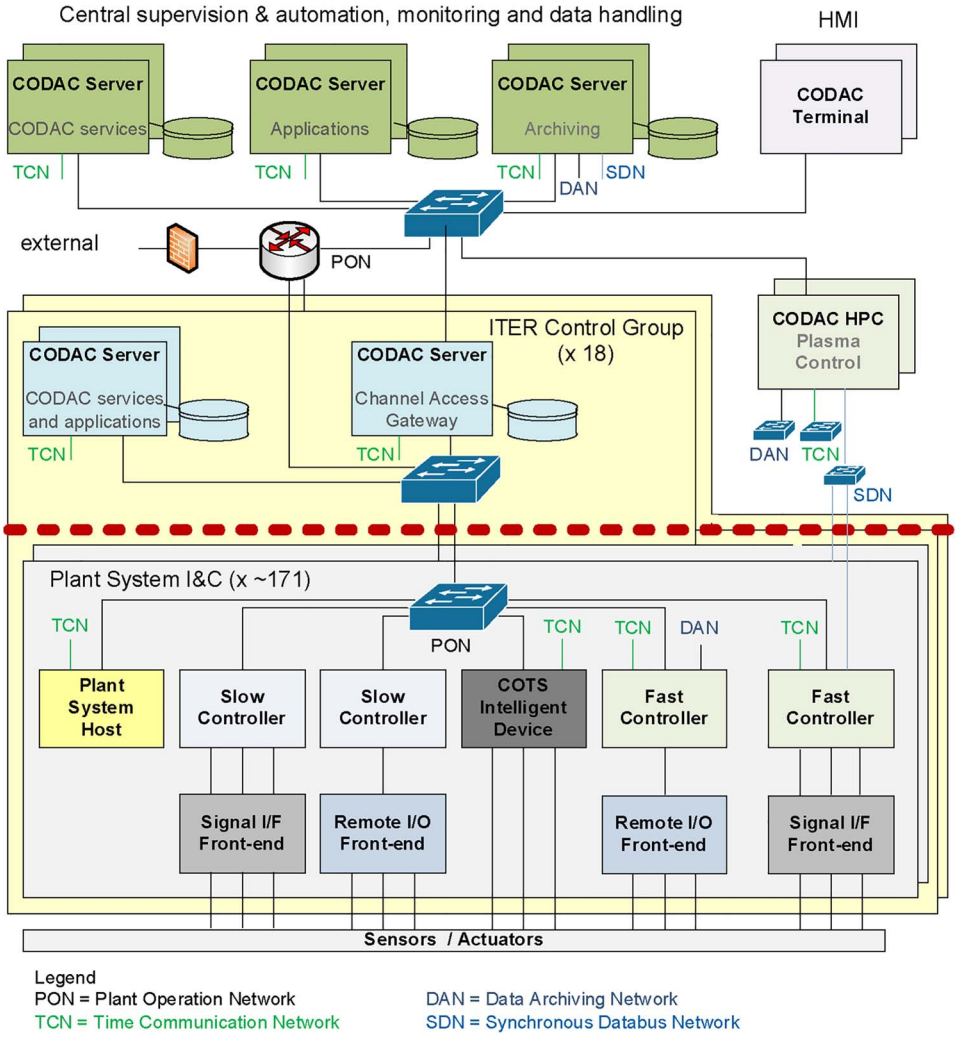

Fig. 1. ITER conventional I&C Architecture.

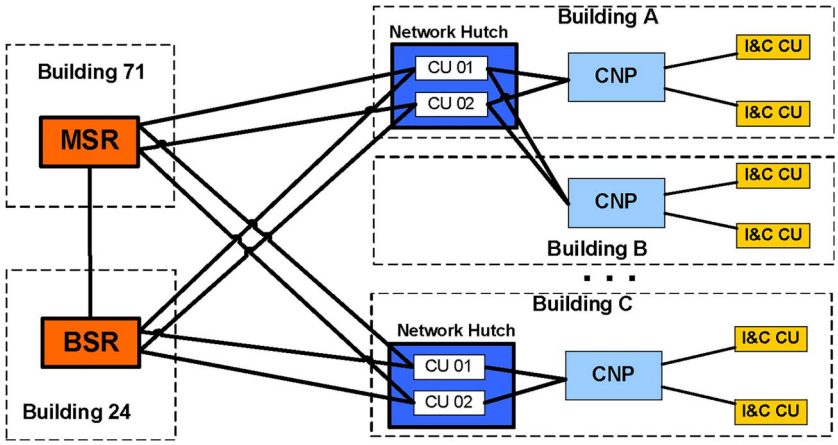

Fig. 2. CODAC Network Infrastructure Architecture.

proper operational environment and adequate uninterruptible power for the active networking components.

As illustrated in Fig. 2, the network hutch connects to plant system I&C cubicles through Central I&C Network Panels (CNP). CNP is a wall-mounted enclosure and will be installed in the vicinity of the plant system I&C cubicles.

All the infrastructure connections are implemented by single mode fiber optics cables.

2.2. PON

PON is a general purpose TCP/IP communication network connecting all hosts of the ITER I&C system for plant operation. PON is a fully redundant network using the dual-star and three-layer hierarchical architecture as shown in Fig. 3: the core layer, the aggregation layer, and the access layer.

The core layer consists of two core switches located in MSR and BSR