An Instrumentation and Measurement Architecture Supporting Multiple Control Monitoring Frameworks

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Abstract. Virtual and/or experimental networks capable of supporting an entire new set of applications and services (Future Internet, Grids, Cloud Computing, other) use, typically, different Control and Monitoring Frameworks (CMFs). This paper addresses the multiple federated CMFs instrumentation and measurement problems. A monitoring architecture (FIBRE-BR I&M Architecture) is briefly introduced by illustrating its basic components and services and its capability to integrate different CMF's I&M Services is also discussed.

Introduction

Future Internet between Brazil and Europe (FIBRE) is a project that aims at building a shared large-scale experimental facility. FIBRE will federate Brazilian (FIBRE-BR) and European (FIBRE-EU) network resources using different Control Management Frameworks (CMFs) geographically distributed in Brazil and Europe [Pinheiro 2011]. One of its goals is to provide Instrumentation and Measurement facilities in order to help experimenters, network administrators and researchers to define experiments and collect infrastructure and/or experiment specific data.

FIBRE-BR uses three different control and monitoring frameworks in its nine islands: OFELIA Control Framework, cOntrol and Management Framework (OMF) and ProtoGENI [Monteiro 2010].

Monitoring in OMF is achieved by the Orbit Measurement Library (OML) which adopts a client/server architecture. OML is composed by the OML-Service, the OML-Client library, and the OML-Collection-Server. The client library runs on the application code. Measurement data sent from clients may be temporarily stored locally on the OML-Service but are destined to the OML-Collection Server that stores them in

a backend SQL database [White, 2010]. ProtoGENI uses conventional network monitoring tools to measure the testbed's infrastructure as a whole (nodes, routers, links, etc). ProtoGENI uses Instrumentation Tools (INSTOOLS) to gather data from traffic generated from the experiments [Monteiro 2010], which is similar to OML and Leveraging and Abstracting Measurements with perfSONAR (LAMP) [Pinheiro 2011].

Our target is to provide, possibly, with a maximum reuse of the available CMFs services over a new integrated and federated network structure. Some of the various aspects involved include the virtualized equipment, networks and monitored data; the collected data control access; and, finally, the multiple CMFs I&M data integration.

This paper introduces the FIBRE-BR I&M Architecture[1]. It integrates the diverse I&M services, tools and facilities from the multiple CMFs, allowing FIBRE-BR users, possibly transparently to each specific CMF, to benefit from the corresponding infrastructure and experiment specific measurement data.

FIBRE-BR Instrumentation & Measurement (I&M) Architecture

The basic requirement for the FIBRE-BR Instrumentation and Measurement (I&M) Architecture (FIBRE-BR I&M) is the capability to configure, monitor, collect, and display both infrastructure and experiment specific data for distinct federated or individual CMF aggregates. Besides that, the architecture also includes or considers the set of requirements adopted by the FIBRE-BR experimental facility which includes substrate measurements, experiment measurements, privacy of measured data, link measurements, measurement data transmission and storage, component locations, time services and federation. It is important to notice that FIBRE I&M, fundamentally, provides some sort of interface, API or access to the existing CMFs.

The building blocks of the FIBRE-BR I&M architecture showed on Figure 1 leverage from current CMFs measurement capabilities. They create an integration facility that conveys the measured data to other FIBRE-BR I&M services and users through a common schema and protocol, according to its policy and experimental network requirements.

The Orchestration and Configuration Services act on behalf of the users allowing them to configure, to define measurement points, and to orchestrate these measurement data collect facilities according to each individual CMF.

The I&M Portal is another component of the I&M architecture. Its main functionality is to provide a user friendly interface to control and access the measured data. As required by any data sharing facility, the experiment data will be available to users according to a defined policy.

[1] The FIBRE-BR I&M Architecture is initially designed for all Brazilian islands.

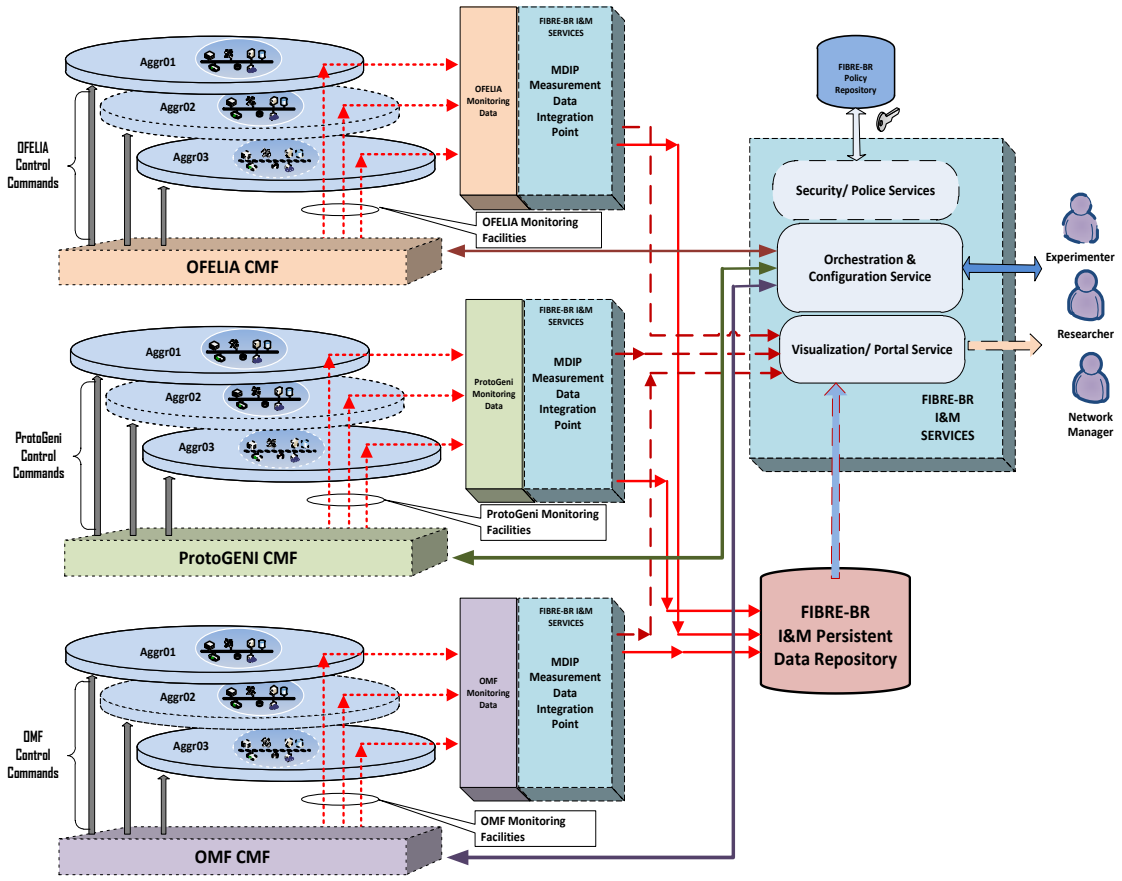

Figure 1: FIBRE-BR I&M Architecture Building Blocks

The Measurement Data Integration Point (MDIP) conforms the collected data from the available CMFs to FIBRE-BR I&M standard format, representation and distribution (including visualization). This service includes all measurement data processing related aspects such as, message format, message transport protocol and/or service, access privileges and common data storage or on-the-fly data distribution.

Finally, in terms of persistent data, the architecture has a storage strategy that allows users to retrieve data from their own or from others previous experiments, according to their access privileges. The persistent storage option is an experimenter decision that must comply with FIBRE-BR retention policy.

MDIP Implementation Aspects

MDIP interfaces with each CMF I&M tool that, in turn, has its own data format and storage mechanisms. MDIP deals mainly with data format and storage issues by, for instance: (1) using SOAP WebServices (XML-RPC) to make data available from one I&M tool to the portal; (2) possibly converting the collected data to a common data format among the different I&M tools; (3) using Measurement Archive (MA) services to export data stored, for example in RRD or SQL databases.

MDIP is strongly based on perfSONAR Measurement Archive service which is able to expose collected data using SNMP, SQL Database and measured data stored in Round Robin Databases (RRD) format [Hanemann 2005]. MDIP provides also data normalization and/or conversion to Network Measurements – Working Group (NM-WG) standard, which is XML based, in order to export the collected data to the FIBRE-BR I&M Visualization/Portal services and to store them in the I&M Persistent Data Repository.

For each CMF in FIBRE-BR, MDIP requires a specific I&M implementation in order to deal with tools and architecture involved, data access and format issues. Initially, three cases are considered: OML, ProtoGENI and OFELIA.

As an illustration of the architectural approach, in OMF scenario MDIP interfaces with OML server and sends the requested data to I&M Persistent Data Repository. In this case, a SQL-to-SQL adjustment is required and data format issues are conformed to NM-WG standard. As a second illustration case, the integration with ProtoGENI CMF benefits from LAMP's architecture which is based on perfSONAR. In this specific case, MDIP data manipulation is much simpler due to the fact that perfSONAR format and schema have been adopted by FIBRE-BR I&M architecture.

Final Considerations

FIBRE-BR I&M Architecture is designed to configure and collected data from different CMFs. It is intended to be an instrumentation and measurement evolutionary architecture in the sense that, firstly, it evolves from integrating single aggregates belonging to common CMFs to, secondly, integrating federated aggregates from multiple CMFs. The proposed architecture in this paper aims at solving most of the associated challenges in the I&M scenario of Future Internet applications.

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