

OPERATOR INTERVENTION SYSTEM FOR REMOTE ACCELERATOR DIAGNOSTICS AND SUPPORT



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Abstract

Large experimental physics projects, such as ITER and LHC, are typically managed by international collaboration. Similarly, the International Linear Collider (ILC), a next generation project, will be launched as a result of the collaborative efforts of multiple institutes from three regions. After its collaborative commencement, all collaborators apart from the host country will need to have methods for remote maintenance, control, and monitoring of its associated devices. For example, a method has to be provided for connecting to the control system network via wide area network (WAN) links from various collaborating institutions. However, from a practical application standpoint, the remote operation of an accelerator via WAN is beset by a number of issues. One such issue is that the accelerator has both experimental device and radiation generator characteristics. Additionally, any mistake operation of the remote control system could result in an immediate breakdown. For this reason, we propose the implementation of an operator intervening system for remote accelerator diagnostics and support that can obviate any differences between the local control room and remote locations.

Purpose of our work was ...

to realize safe remote control for EPICS-based WebSocket operation by the on-site operator intervention (Allow/Deny judgement for EPICS PVs), because we have to prevent a mistake operation and a machine trouble.

User Interface for remote operation (WebSocket-based OPI)

Send operation request

Waiting for on-site the judgement of operator

DATE: 13/09/10 19:11:52

Control available

Control

GA51 (O2) Fast VALUE 71.0713 OPEN CLOSE

GA52 (Xe) Fast VALUE 73.6600 OUT IN

Extraction Position VALUE 56.4102 OUT IN

Bias Disk VALUE 21.9954 OUT IN

Oven VALUE 7.9398

RF No.1 DAC PF [W] PR [W] RF No.2 (Gylotron) DAC PF [W] PR [W]

LV OFF HV OFF Not Accept

LV OFF HV OFF Not Accept

BIAS PS DAC Voltage [V] Current [A] Oven PS

DOWN UP

DOWN UP

Monitor

VAC Plasma VAC Ext VAC E11

2.8e-5 Pa 1.9e-6 Pa 1.7e-6 Pa

Ext PS V [kV] Ext PS A [mA] Accel/Decel PS V [kV]

-0.0020 -0.0015 -0.0015

Gylo HV [kV] Gylo HV [A] Gylo Fil [A]

0.0236 0.0595 -0.0025

Gylo Sub Coil [A]

-0.0025

FC_U10

1000000

0

User Interface for on-site operator (Web application using Ajax)

EPICS Operator Intervening System

Home Access Log EPICS Put Log Gateway Report Access Security Logout

Request device name from remote location

REQUEST PVs

ID	User	PVs	Request Time	Limit
103	epics	akito12:xxxExample	2013-07-29 13:27:49	✓
105	epics	akito12:calc2	2013-07-29 13:28:06	

ALL NEXT CANCEL

RESERVED TIME 1min

ACCEPT DROP

IN-OPERATION

User	Operator	PVs	Time	Drop
epics	akito12	akito12:calc1	1 min	✗

Device name in remote operation

Stop operation

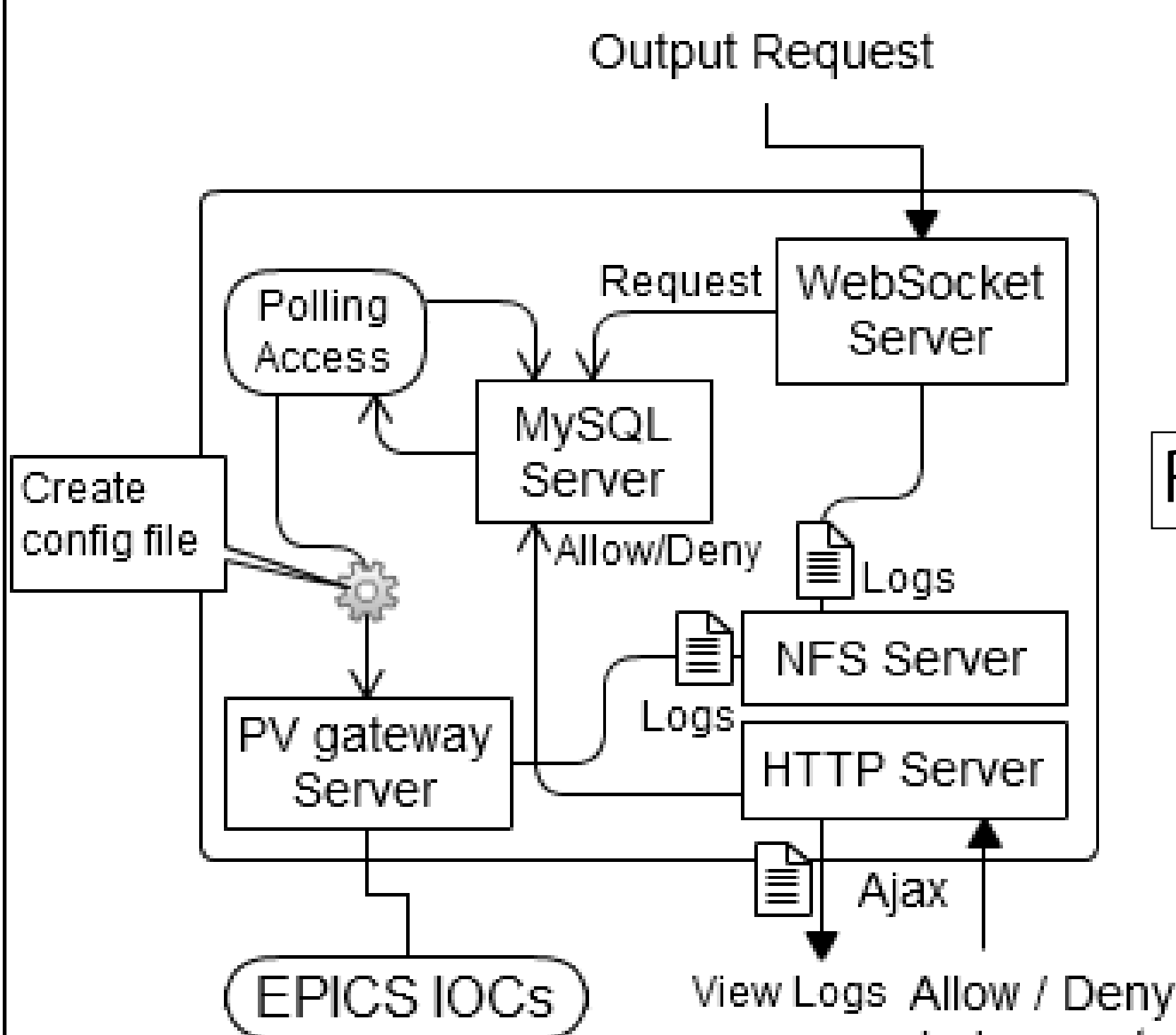
Set duration time

DONE PVs

ID	User	Operator	PVs	Request Time	Accept Time	End Time
102	root	akito12	akito12Host:xxxExample	2013-07-25 18:38:17	2013-07-25 18:43:35	2013-07-25 18:53:35
101	root	akito12	akito12Host:xxxExample	2013-07-25 18:37:50		NOT Accepted PV
100	epics	akito12	akito12Host:calc2	2013-07-20 03:36:34	2013-07-20 03:47:41	2013-07-20 04:17:41
99	epics	akito12	akito12Host:calc1	2013-07-20 03:36:30		NOT Accepted PV
98	epics	akito12	akito12Host:xxxExample	2013-07-20 03:36:23	2013-07-21 05:16:06	2013-07-21 05:46:06
97	epics	akito12	akito12Host:xxxExample	2013-07-20 03:07:42		2013-07-20 03:34:35
96	epics	akito12	akito12Host:xxxExample	2013-07-20 03:07:21		2013-07-20 03:34:35

Done devices list

Overview of the system



System policy

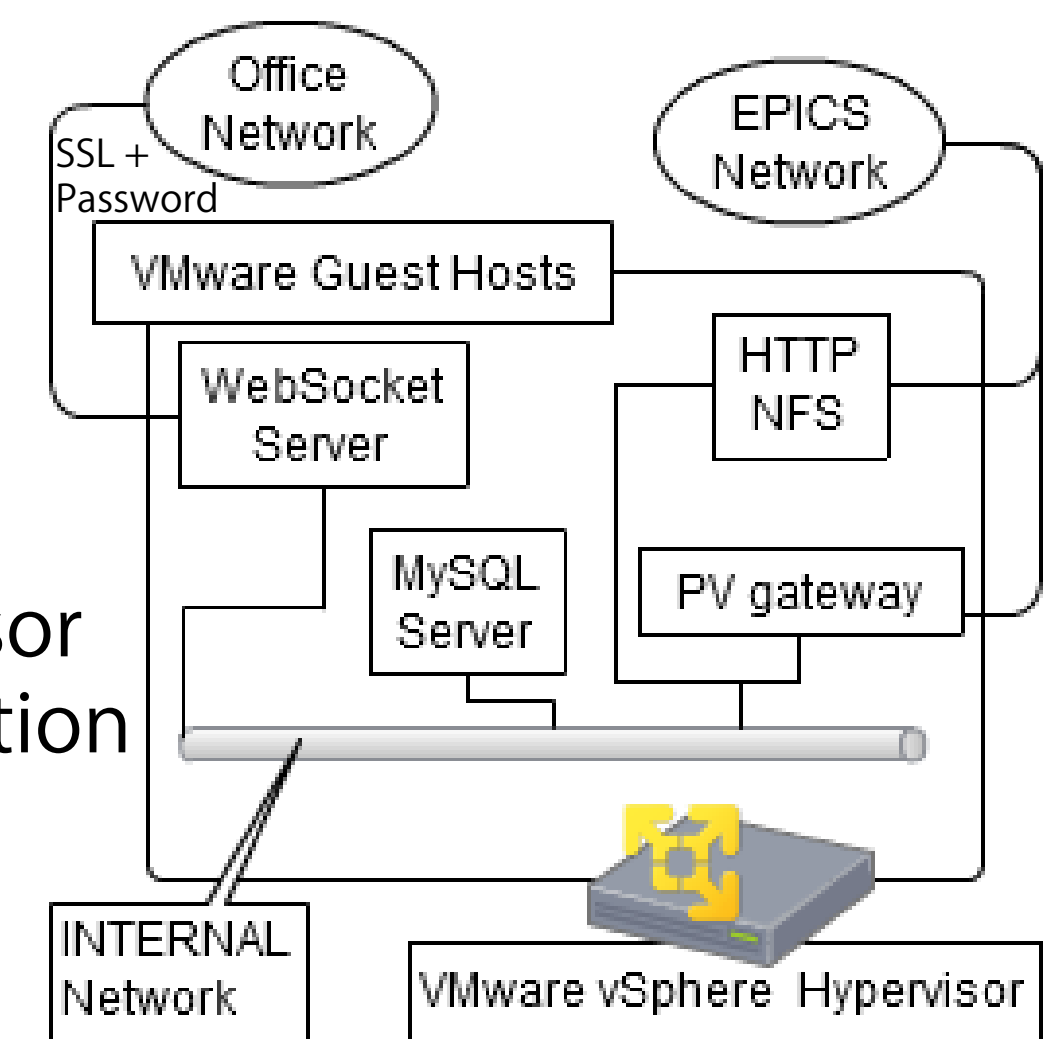
- The operator intervention system can control the availability of remote operations by sending system flag values to the MySQL database.
- The access control mechanism for the CA protocol is utilized by the access control security system of the PV gateway (GATEWAY.pvlist).

Required services

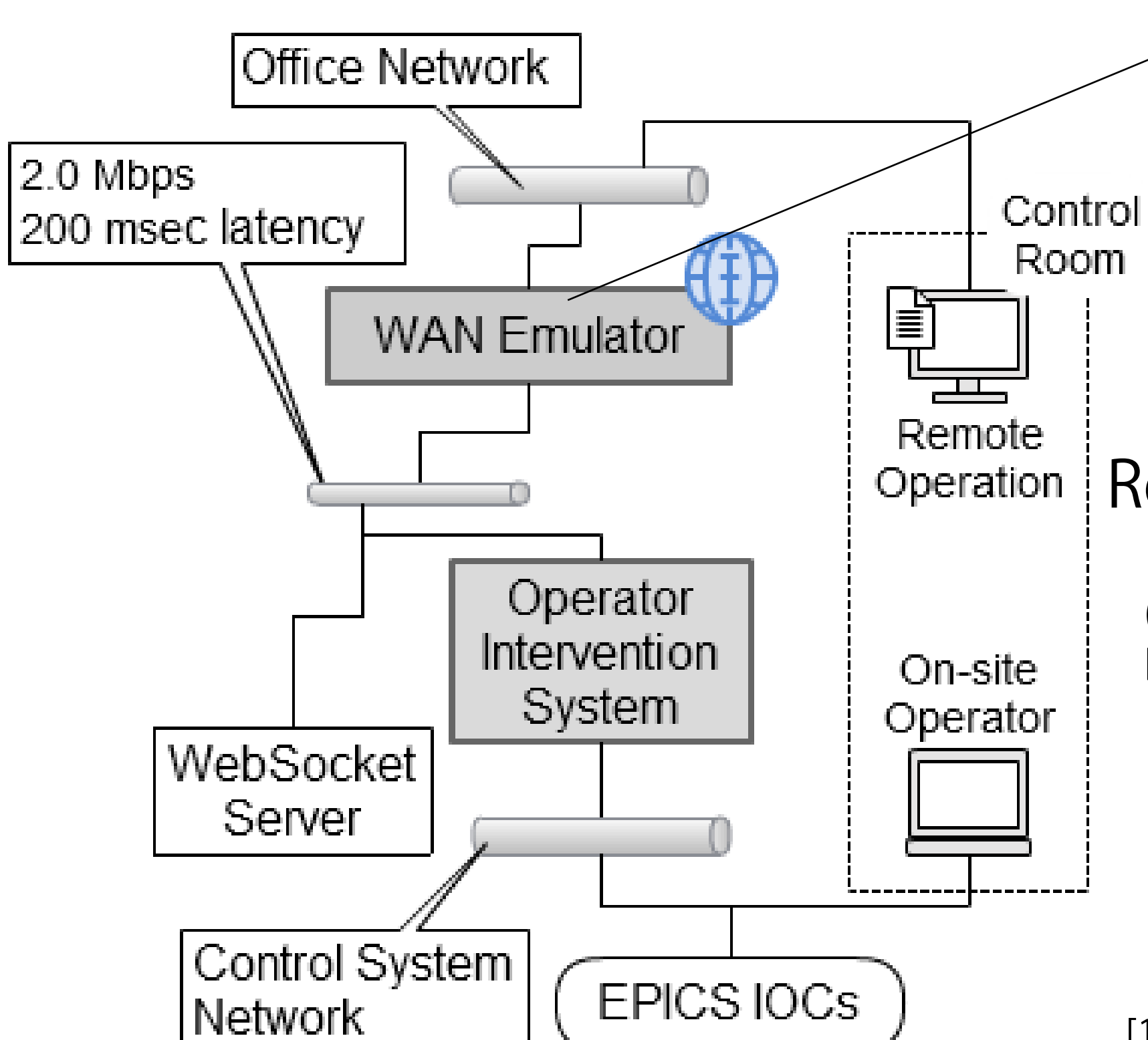
- MySQL
 - The access control mechanism use stored flag values
- EPICS PV gateway (Customized)
 - Implementation of the upper and lower limit function (GATEWAY.limit file) by modified source code.
- WebSocket server (coded by Node.js)
- Apache + PHP (LAMP)
 - Use Ajax for the development because interactive response is not essential.
- NFS
 - This is used to share the logs among hosts.

Defense-in-depth network

- The EPICS access security control is **not suitable** method for accessing from Internet because of **impersonation**.
- So, we use virtualization environment to construct multi-layer network architecture
- This is one of the most useful methods for improvement of network security.
- VMware vSphere Hypervisor was adapted for virtualization software.



Test system using WAN emulator [2]



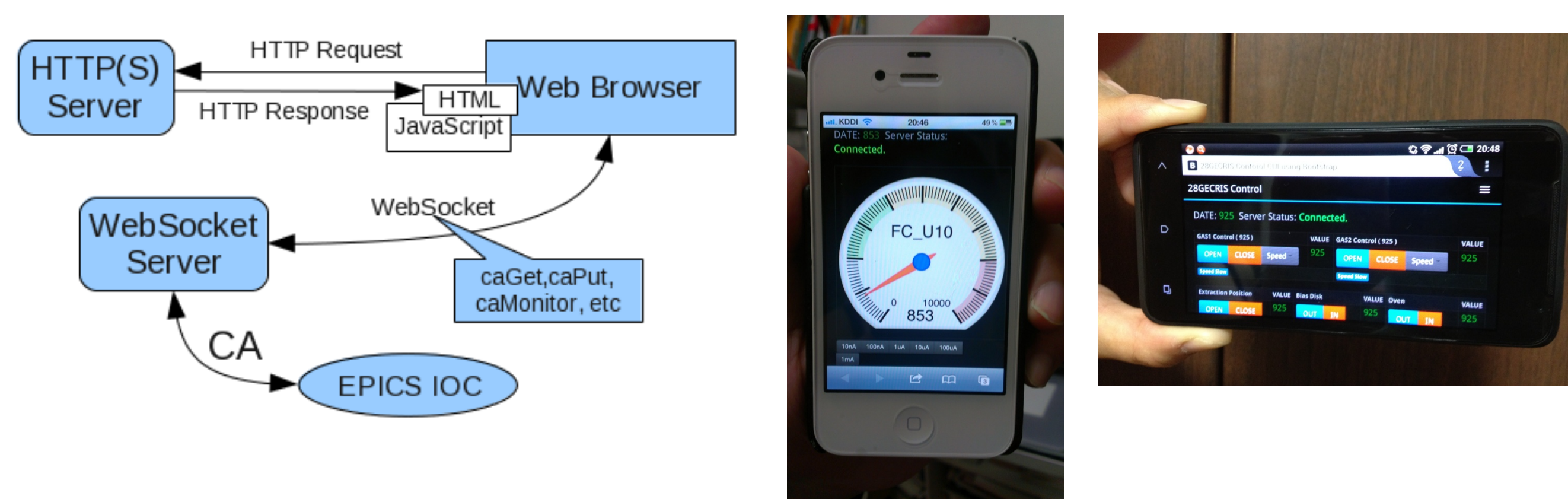
WAN(Wide Area Network) emulator creates another network with a performance of 2.0 Mbps and 200 msec latency = Networking performance as between Japan and U.S.A.

Result of the test system

- We were able to successfully operate part of the 28GHz SC-ECRIS (gas valves, RF power, electrode position, and so on) in RIKEN RI Beam Factory.
- We confirmed that the output instructions were not reached to EPICS IOC without on-site operator permission.

WebSocket Operator Interface

- WebSocket = New protocol to realizes an interactive response using bidirectional communication with web. (Ajax is not suitable.)
- We developed WebSocket -based OPI for EPICS-based control system [1]



iPhone, Android are also Available!