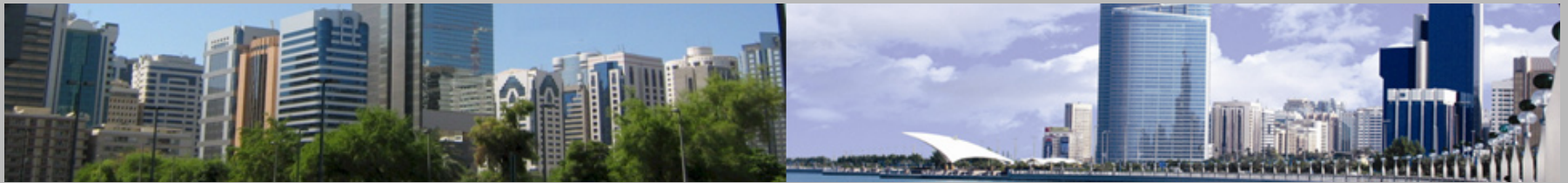


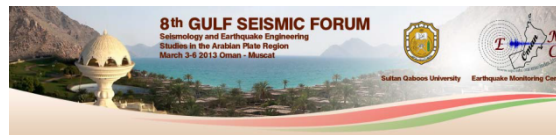
Experiences with Disaggregated Data and Display Centers for Seismic Hazard Monitoring: A Case Study from the Abu Dhabi Emirate, UAE



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**SULTAN QABOOS UNIVERSITY
EARTHQUAKE MONITORING CENTER**



**8th Gulf Seismic Forum
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OUTLINE

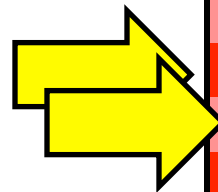
- 1. Introduction**
- 2. Hardware**
- 3. Communication**
- 4. Data Sources**
- 5. Video Components**
- 6. Experiences Acquired**
- 7. Outlook**



INTRODUCTION

PROJECT OUTCOMES

- Enhanced planning and policy tools for rapid response during seismic induced state of emergencies
- Engineering data and information for enhanced design and protection of an evolving infrastructure
- A scientific understanding into the dynamic structure underneath the Emirate



TK	DESCRIPTION
01	Seismic Zoning
02	Site Amplification & Microzonation
03	Liquefaction Susceptibility Study
04	Seismic Design Parameters
05	Risk Analysis of Lifelines
06	Risk Analysis of Critical Structures
07	Permanent Accelerograph Network
08	Seismic Monitoring Network
09	Ground Shaking Map
10	Structural Health Monitoring
11	3D Seismic Simulation Model
12	Risk Analysis of Tall Buildings
13	Loss Estimation
14	Data Management Centers
15	GIS Seismic Database
16	Coordinated Activities
17	Promotion & Public Awareness
18	Training
19	Build, Operate, and Transfer (BOT)
20	Maintenance

INTRODUCTION

Objectives

- Real-time data acquisition & processing
 - Accelerograph network
 - Seismic monitoring network
 - Structural health monitoring systems
 - Data exchange with other networks in the region
- Data storage & maintenance
 - Relational data base of seismic information
 - Geographic Information System
- Information dissemination & display
 - Event location and magnitude
 - Ground shaking map
 - Structural health status of seven (unique) buildings
 - WebGIS with damage and lost estimations
 - State-of-health of remote dataloggers & com-links

INTRODUCTION

Description

– 2 Data Centers

- Abu Dhabi Municipality (ADM)
- United Arab Emirates University (UAEU) via Al Ain Municipality (AAM)
- Mirror operation

– 5 Display Centers

- Abu Dhabi Municipality (ADM), Al Ain Municipality (AAM), Western Region Municipality (WRM), Abu Dhabi Police Headquarters (ADP), National Center for Meteorology and Seismology (NCMS)
- Independent access to video feeds, graphic user interfaces and web-services from both Data Centers

– Communication Infrastructure

- Government Intranet: Abu Dhabi Network (ADNet)
- GRE tunnels between the different entities

Hardware

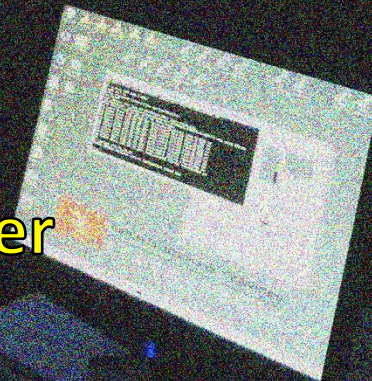
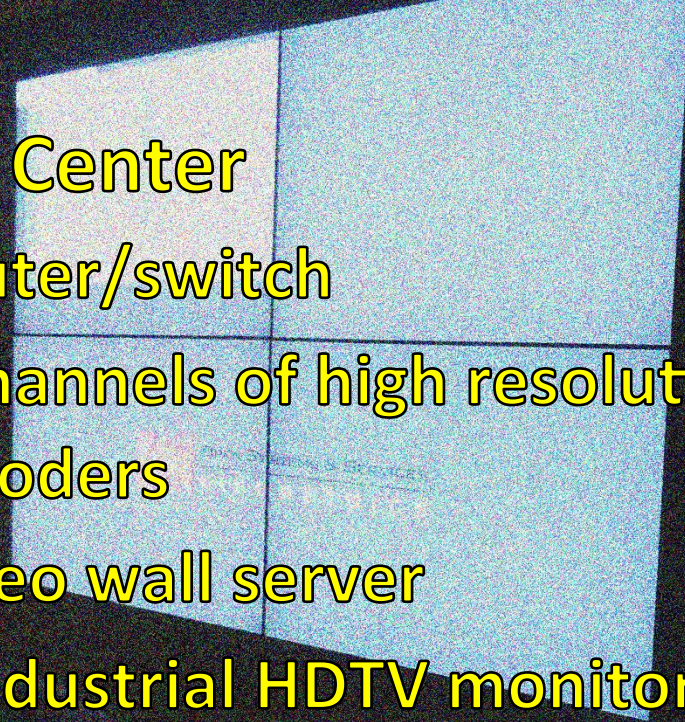
Data Center

- 2 load-sharing data acquisition workstations
- 2 mirrored data processing workstations
- 2 SHM processing workstations
- Analyst workstation
- Web server
- GIS database server
- GIS application and web-server
- 16 channels of high resolution video to IP encoder(JPEG2000)
- 4 channels of low resolution video transcoder (H.264)
- LAN equipment

Hardware

Display Center

- Router/switch
- 4 channels of high resolution IP to video decoders
- Video wall server
- 4 industrial HDTV monitors (42in with ultra-narrow bezel)
- Laptop
- Network printer



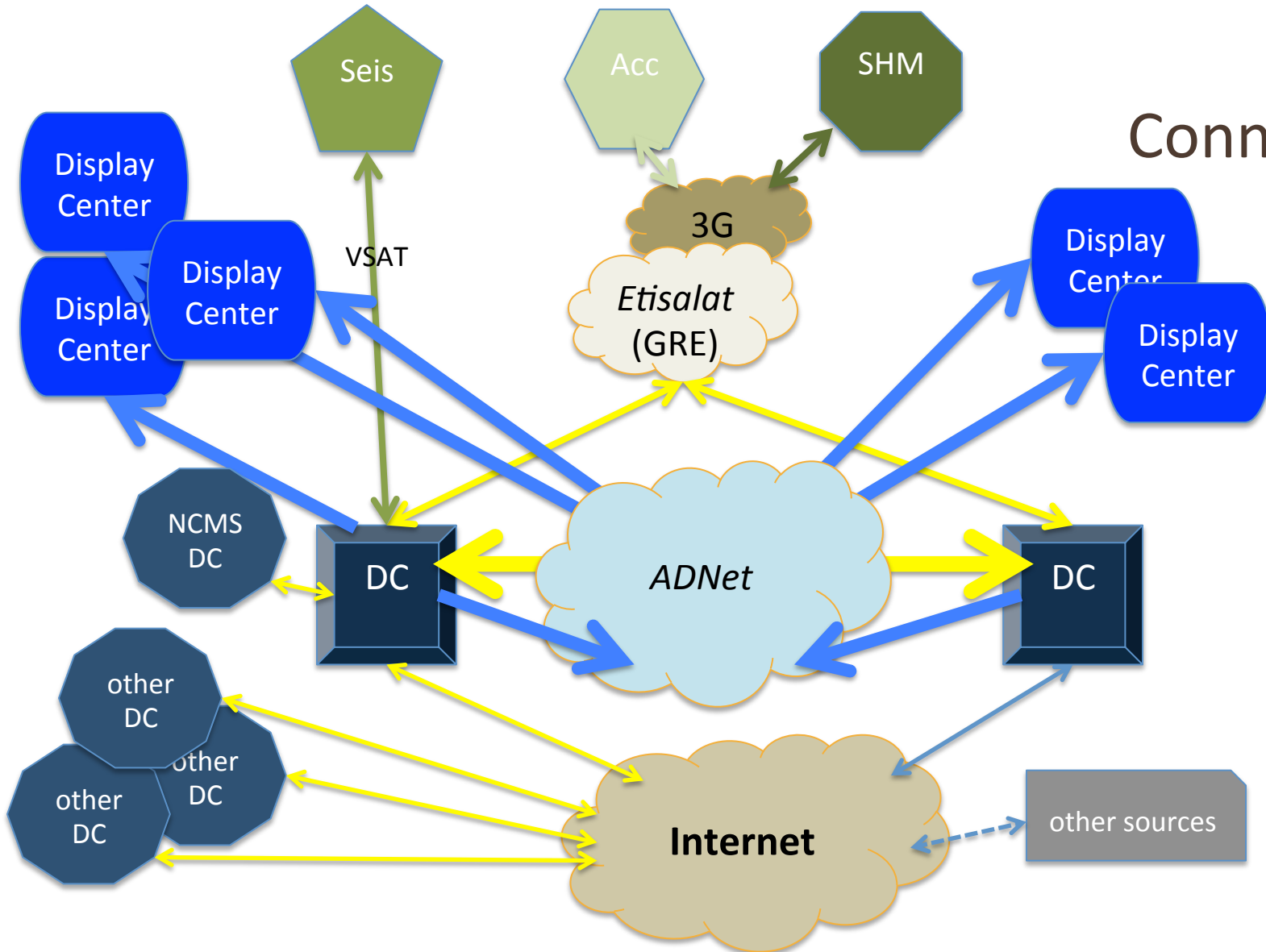
Communication

A reliable and high bandwidth communication infrastructure is required in order to realize a disaggregated system.

- The Antelope middleware binds all data sources into redundant (where possible) acquisition links. In order to achieve this, a program is required that
 - Handles multiple physical communication links from the members of the system → ***link-redundancy***
 - Assures that data packets are not duplicated → ***data uniqueness***
- 3 routers at each Data Centers for inter Data Center communication, data acquisition, Internet access
- GRE tunnels between all entities via ADNet
 - Permits data exchange between the Data Centers
 - Permits synchronization tasks between Data Centers
 - Permits multicast of video feeds form Data Centers to Display Centers
 - Permits X-Forwarding graphic user interfaces

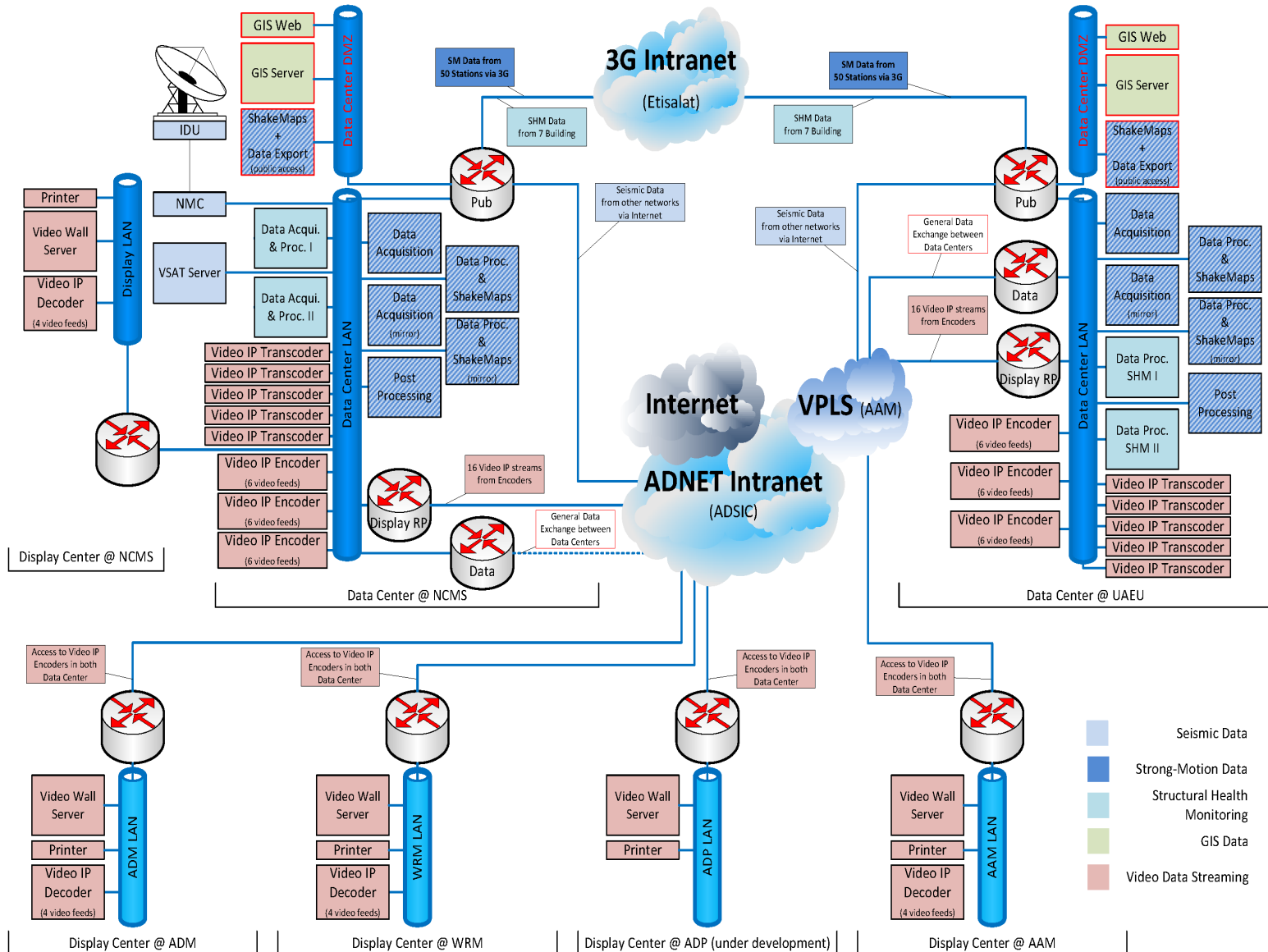
Communication

Logical Connections



Communication

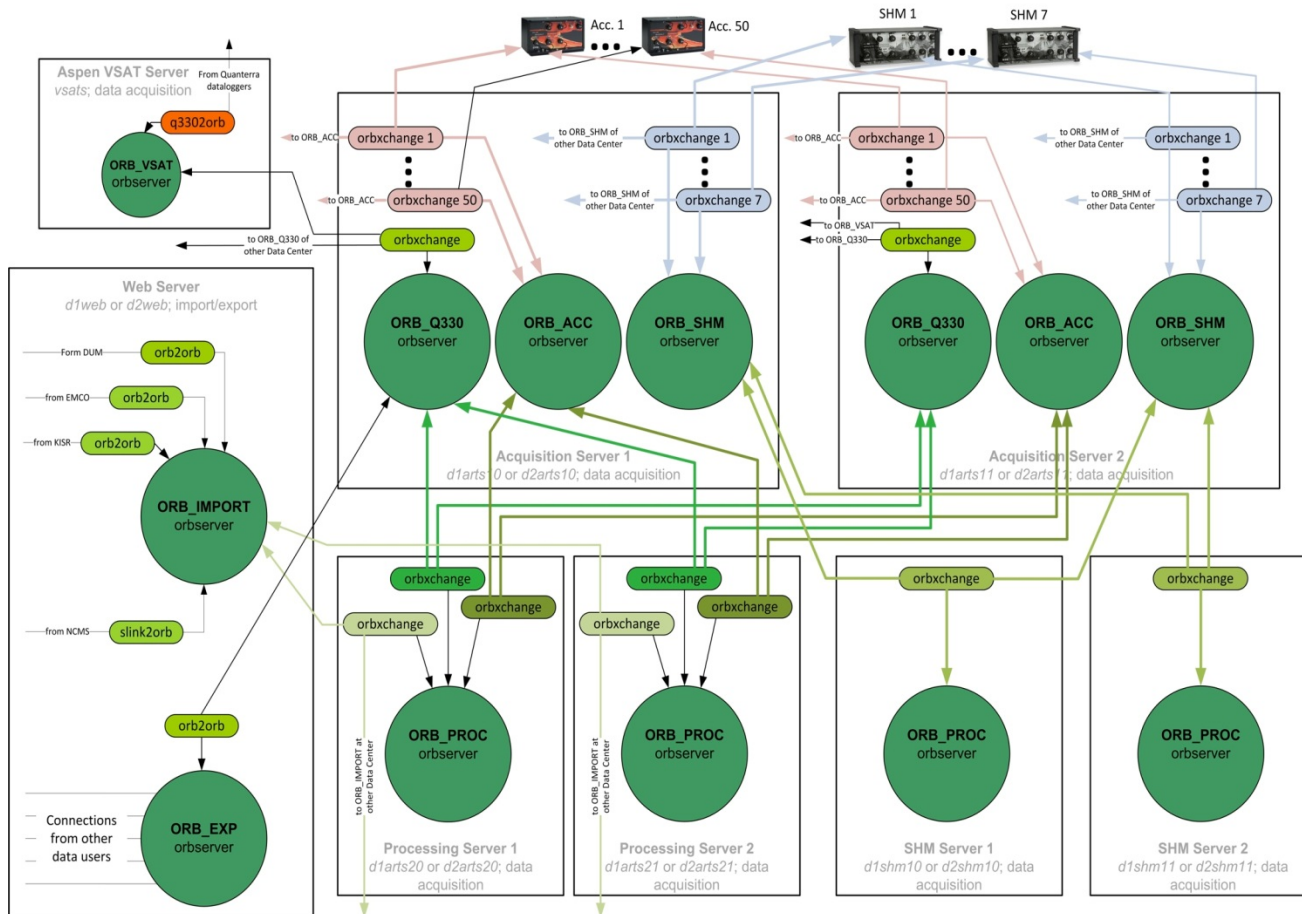
ADSHRA Seismic Risk Monitoring and Management Center TK-14
System Drawings, System Layout, Rev. X14



Data Sources

Data Center

Each data center is operating in parallel as mirror. That permits the instant and complete substitution of all functions of the other one. Actually, all resources, data and information are available at all times from both systems. Also, the data centers are interconnected using the link as alternative data acquisition link and for synchronization of data, meta-data, and information when required.



Data Sources

Seismic Network

In the scope of the project the national seismic network of the UAE (operated by NCMS) was augmented by four (4) stations. Each station communicates via VSAT satellite link to the VSAT hub at NCMS. As external sources are aggregated the data streams of the existing seismic network.



Ghayathi



Sila'a



Um Zummoul

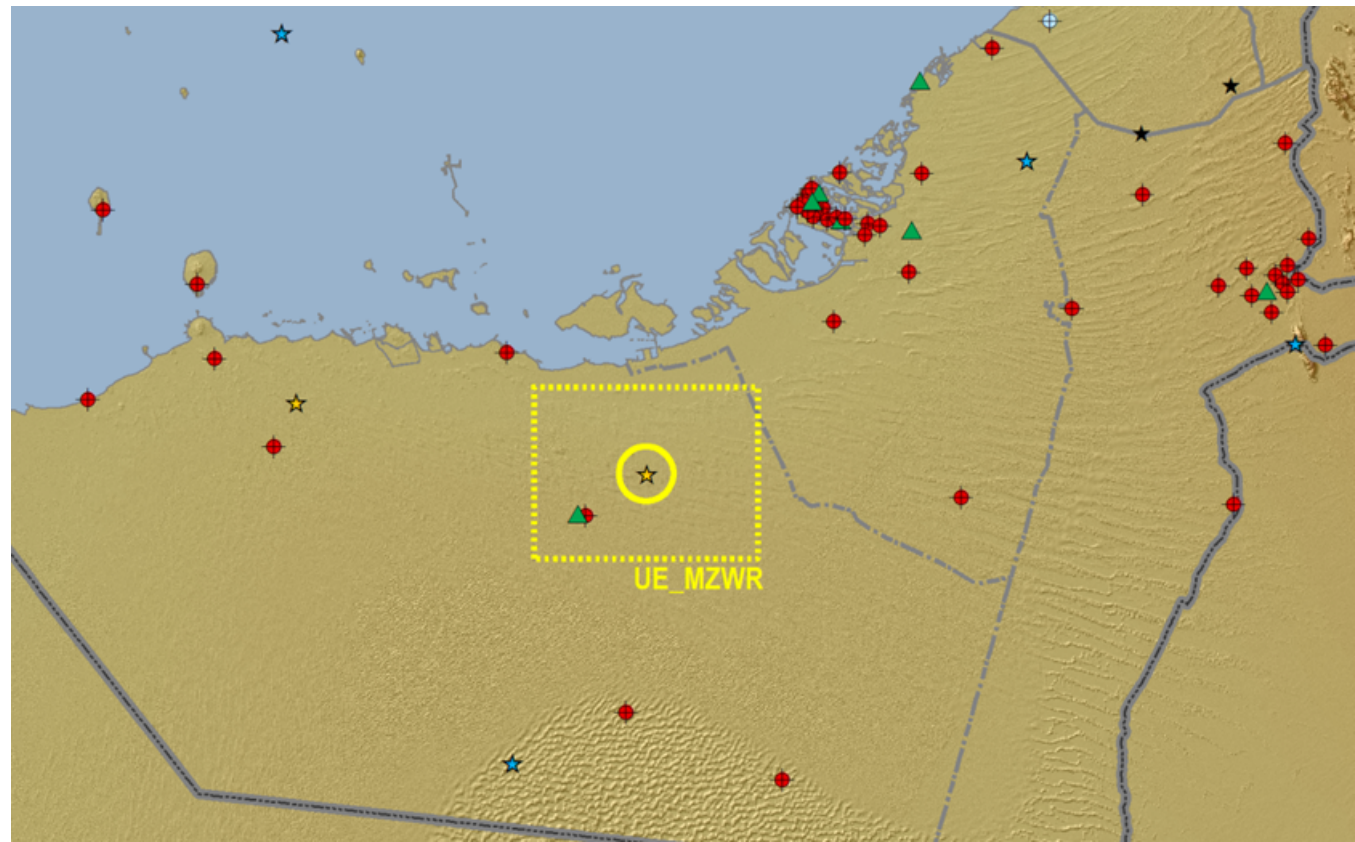


Madinat Zayed

Data Sources

Accelerograph Network

The 50 stations of the accelerograph network are connected to Etisalat's 3G network. From Etisalat a dedicated communication link for each data center delivers independent and alternative communication feeds.



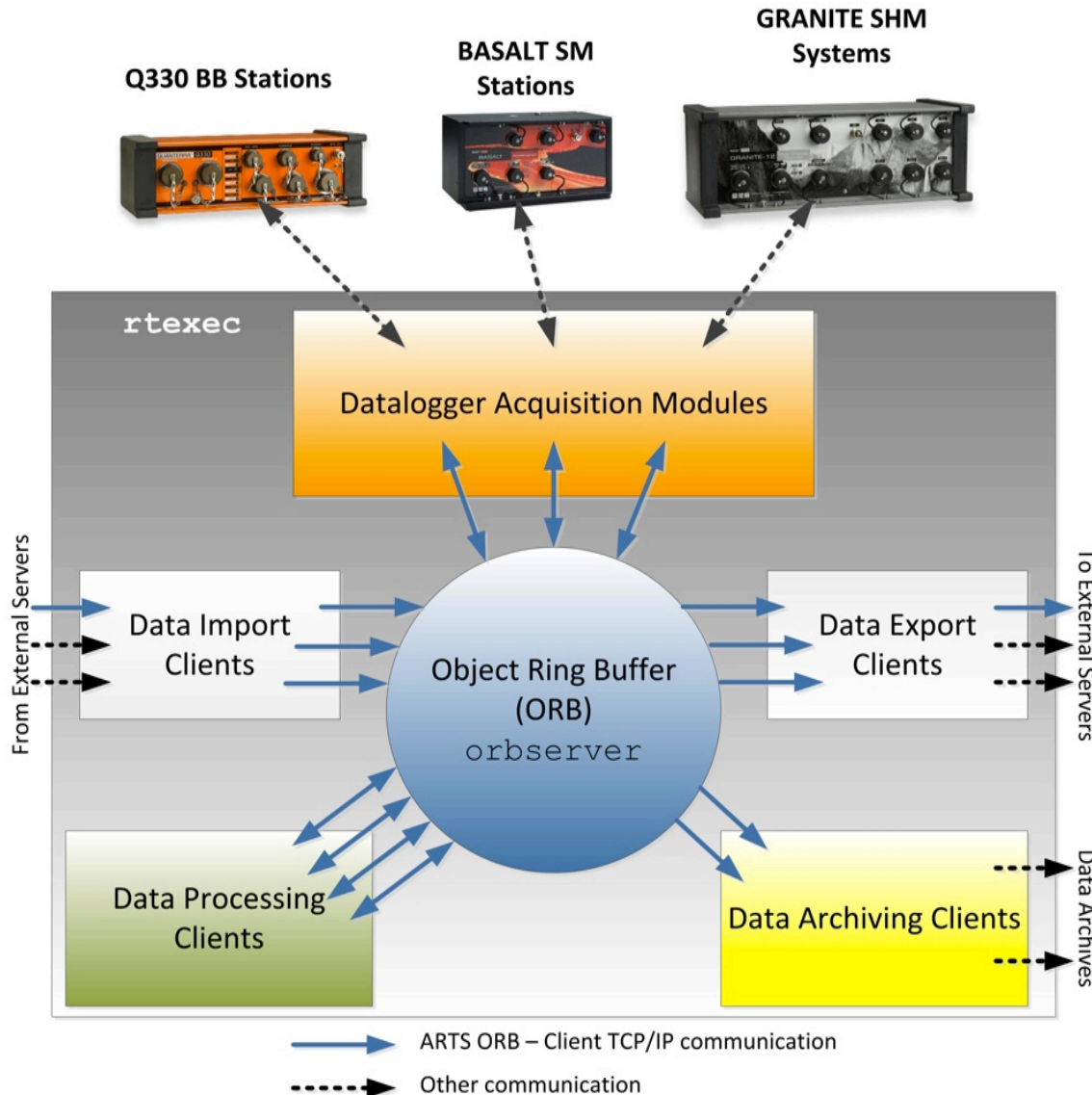
Data Sources

Structural Health Monitoring

In the Abu Dhabi Emirates seven (7) unique structures are instrumented for structural health monitoring. Each structure has 24 or 36 acceleration channels plus a wind sensor. Each structure is connected to both data centers through 3G wireless or over DLS.



Data Sources



Other sources

The exchange of real-time seismic data is realized through an Internet connection at each data center.

Currently, data exchange will be carried out between the Dubai Municipality, the Seismic Monitoring Center of Oman and KISR in Kuwait including a selection of GSN stations.

Video Components

Data Centers

- SVSi encoders provide up to (16) video channels in JPEG2000 quality and (4) transcoders provide (4) lower resolution video channels in h.264 format.
- Bandwidth requirement per channel at Display Center: ~8Mbps (JPEG2000) and ~1.2Mbps (h.264)
- Multicast broadcast capability via IGMP (Internet Group Management Protocol). The IGMP is carried via the ADNet provided GRE (Generic Routing Encapsulation) connections from the data centers to the display centers.
- Rendezvous points are established in the router at the GRE tunnel endpoint.
- The video software (running in a Virtual Machine) allows the user/operator configuring the quality, number and availability of the video feeds per display center. Moreover, the software can enforce to show certain channels at all display centers simultaneously. In case of a crisis, this feature can be used to broadcast predefined emergency contents or synchronize the video walls at the display centers so that the personnel can collaborate on the same available information. In the future these capabilities can be harness to develop a disaggregated “situation room.”

Video Components

Display Centers

- The display center consists of a 2-over-2 video wall of 42in HDTV industrial displays.
(4) video decoders for JPEG2000 multicast connections.
The video wall server handles the graphical input and the size/location of the input on the video wall.
- The graphical input can be divided into two sub-classes:
 - Direct video feeds from the graphic cards at the data centers in high resolution with JPEG2000
 - VLC video feeds with Internet streaming resolution (h.264) from the transcoders



Graphic Output

Display Centers

- Graphic User Interfaces via X-forwarding waveform data, event map, datalogger state-of-health
- Web-pages of ShakeMap and the WebGIS

بلدية مدينة أبوظبي
MUNICIPALITY OF ABU DHABI CITY

Station	Latitude	Longitude	Depth	Magnitude	Time
US_AJ01	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ02	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ03	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ04	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ05	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ06	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ07	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ08	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ09	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ10	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ11	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ12	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ13	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ14	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ15	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ16	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ17	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ18	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ19	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ20	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ21	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ22	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ23	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ24	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ25	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ26	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ27	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ28	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ29	24.45	54.35	10	2.5	2012-10-31 08:15:00
US_AJ30	24.45	54.35	10	2.5	2012-10-31 08:15:00

Experiences Acquired

Data Center

- Database replication frequency will be hourly
- Mirroring of Data Center increases bandwidth requirements to data sources
- Bandwidth requirement +20Mb
- Although information is available in both centers, only one Data Center at a time is the “declared” authoritative
- Procedures define failover and failback between Data Centers

Display Center

- X-forwarding of GUIs produces better resolution with less bandwidth than IP video feeds.
- In a “best effort Intranet”
 - video feeds need to be on a separated connection than the entities’ business LAN in order to mitigate negative impacts
 - Alternatively, each Display Center assigns a given minimum bandwidth $\geq 6\text{Mb}$.

Outlook

The Future Situation Room

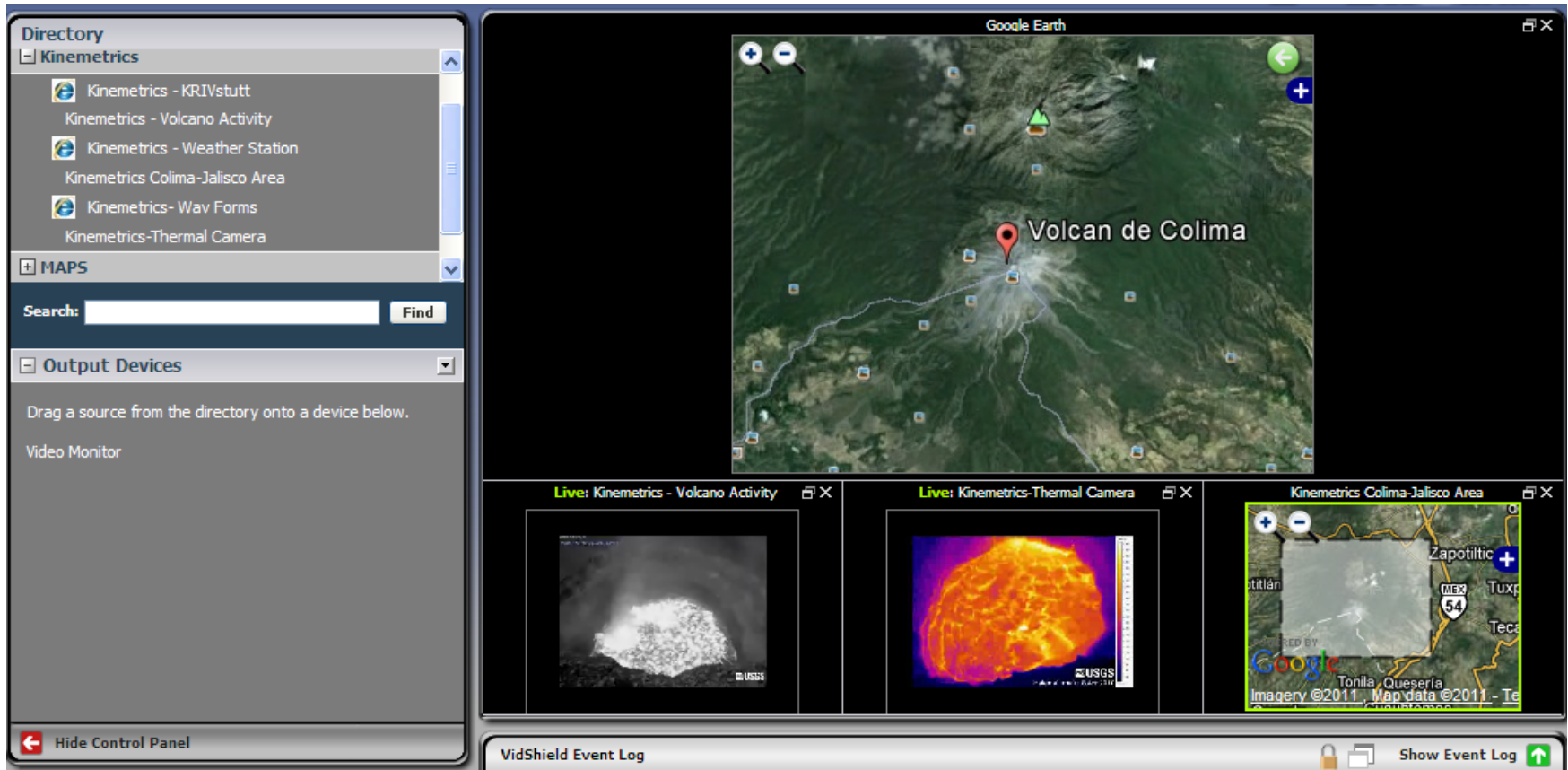
Graphical information can be flexible and on-demand distributed to one or more users. However, the information consumer is not necessary versatile in the intricacies of the available information. Therefore, another program layer is required that

- prepares the existing information so that it is conducive, e.g., for the first responder or other officials involved in emergency response, to carry out the task or request on hand,
- supplies instructions or protocols how to respond to a given situation according to standard processes and policies, and
- connects to a dispatch systems

Outlook

The Future Situation Room

Besides the seismic and structural engineering content, other relevant sensors and video cameras may be included promoting a complete situation awareness.



Thank You

The screenshot shows the VidShield web interface. At the top, there is a navigation bar with a "Launch RiskShield" button indicating "4 Pending, 0 Assigned" and a "Logout" link. Below this is a "Virtual Tracker" section. The main content area features a Google Earth map centered on "Volcan de Colima". At the bottom, there are three live video feeds: "Kinematics-Thermal Camer", "Kinematics - Volcano Activi", and "Kinematics Colima-Jalisco Area". A "VidShield Event Log" is visible at the very bottom.

The screenshot shows a Windows Internet Explorer browser window displaying weather data for AR390. The top window shows "AR390 - Air Temperature" and "AR390 - Station Pressure" graphs. The bottom window shows "AR390 - Wind Speed" and "AR390 - Wind Direction" graphs. Below the graphs, there is a "waveforms.jpg" image showing multiple seismic or vibration traces. The browser's address bar shows the URL "http://127.0.0.1/content/waveforms.jpg".