WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP
ON INTEGRATED OBSERVING SYSTEMS

WORKSHOP ON RADAR DATA EXCHANGE

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CONSTRAINTS TO INCREASED WEATHER RADAR DATA EXCHANGE

Understanding the technical Information Systems constraints

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SUMMARY AND PURPOSE OF DOCUMENT

Potential use case, technical and financial constraints of various technologies for data exchanges.

ACTION PROPOSED

The meeting is invited to take the information provided into account.

Understanding the technical Information Systems constraints

1. Introduction

Advances both in technology and in science are driving an increase in the amount of information that is being requested from operators of weather radar systems. Added to this is the need to combine data from radars across continents to produce consistent composite coverage. This explosion in the amount of information to exchange resembles the growth in the volume of information from satellites.

This paper considers some the main telecommunications technologies, together with a summary of their key technical and financial attributes, and also describes potential use cases of such solutions.

2. Telecommunications technologies

Key telecommunications transmission methods, are outlined in Table 1.

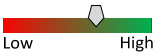
Table 1. Summary of telecommunications technologies used for bulk data exchange

Technology	Description
Mobile telephony	Send and receive data over the mobile telephone network.
Satellite broadcast	Usually uses "digital video broadcast" or "digital audio broadcast" standards. Files or streams of information are uplinked to a satellite and broadcast over a broad area.
Satellite upload	Similar to mobile telephony for transmitting information, but uses uplink to satellite and so has almost global coverage. Depending on the technology, dedicated fixed transmitting equipment may be required. Iridium, though, operates more like a terrestrial mobile telephone service.
Internet	The public internet
Research network	A private internet operated within a research community; usually allows exchange of information with the internet.
Managed cloud – shared	A commercial network offered by an organization that acts like a private internet. Many customers may be active on the network, but each has a service level agreed and the supplier is obliged by the contract to delivery the network to the contract standards (this might include minimum bandwidth, maximum down time, etc)
Managed cloud - private	This is like a shared managed cloud, but the organizations sharing the cloud are closely related. An example is the RMDCN. Although the underpinning technology infrastructure is shared among many user communities, the data flows of those communities are separated by a number of techniques so that the supplier can offer availability and bandwidth guarantees.
Managed private circuit	Single point-to-point link between two sites. Although sold as a private link it will run over shared infrastructure
Dark Fibre	Use existing telecommunications infrastructure (normally fibre optic cables run alongside a major road, railway or powerline). The supplier provides minimal service other than connection to the fibre from the customer's site. Fault resolution normally falls to the customer

Building the “ideal” architecture will then consist on using the various technologies where they are more suited.

Table 2. A high level analysis of the various network technologies

Techno-logy	Geo. coverage	Cost	Reliability	Security	Throughput	Guaranteed Throughput	Guaranteed SLA
Mobile telephony	Low High	High Low	Low High	Low High	Low High	Low High	Low High
Satellite broadcast	Low High	High Low	Low High	Low High	Low High	Low High	Low High
Satellite upload	Low High	High Low	Low High	Low High	Low High	Low High	Low High

Techno-logy	Geo. coverage	Cost	Reliability	Security	Throughput	Guaranteed Throughput	Guaranteed SLA
Internet							
Managed cloud							
Private circuit							
Dark Fibre[1]							

So, when installing a radar in a remote location it is difficult (or impossible) and not cost effective to install a dark fibre. Also, when sending one particular data set to one “client” (eg. radar site to regional or central location) using a satellite broadcast technology is not a cost-effective option.

In the table above, it is important to understand the last two columns. A particular network technology can potentially have a very high throughput; however the guaranteed throughput may very low. In other words, it is not because two sites have each a 10Mbit/s Internet connection that a network transfer will be able to run at 10Mbits/s. Sometime it might, sometime it won’t. It is impossible to guarantee the level of performance and also the performance may vary greatly for one hour to another or from day to day.

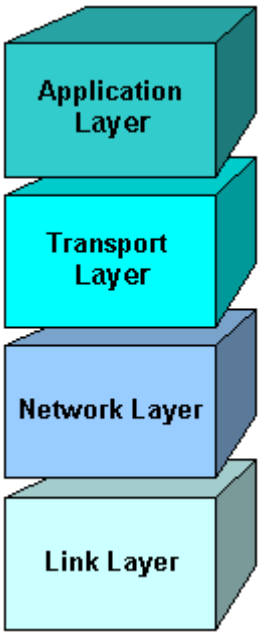
For the SLA (Service level Agreement), it is very similar. Each Internet access of the two sites may have an SLA (eg. guaranteed repair time of 4 hours), but the network in the middle will not have such SLA. So, if something is “wrong” it may take days to be addressed. The Internet is by nature a “best effort” network. When creating a networking architecture, this must be understood and factored in the design of the solution.

[1] The installation cost of dark fiber is usually very high (it requires digging trenches on roads) and the running cost is very low. Depending on the situation and compared to a service offered by an operator, the dark fiber is an investment that could require ten years to be financially interesting.

3. A very brief introduction on networking technologies

In order to understand what are the challenges for exchanging radar data between various sites, it is important to introduce some basic points of networking vocabulary.

1. The TCP/IP layer model



A simplified version of the TCP/IP layer model is shown on left.

- The link layer corresponds to:
  - Private Circuits
  - Dark Fiber
  - Mobile Telephony
  - Managed cloud
  - Satellite Broadcast
  - Satellite upload
- On the network layer :
  - IP
- On the transport layer
  - TCP (Transmission Connect Protocol)
  - UDP (User Datagram Protocol)
- On the Application layer
  - FTP

2. Unicast, Multicast and Broadcast

From Wikipedia, the definition of these terms:

Unicast: In computer networking, unicast transmission is the sending of messages to a single network destination identified by a unique address.

Multicast: In computer networking, multicast is the delivery of a message or information to a group of destination computers simultaneously in a single transmission from the source. Copies are automatically created in other network elements, such as routers, but only when the topology of the network requires it.

Broadcast: In telecommunication and information theory, broadcasting refers to a method of transferring a message to all recipients simultaneously. Broadcasting can be performed as a high level operation in a program, for example broadcasting Message Passing Interface, or it may be a low level networking operation, for example broadcasting on Ethernet.

With the exception of the satellite broadcast, the other technologies are mainly Unicast oriented (eg. an FTP file transfer is between two systems).

It is possible but rather unusual to use Multicast technologies on terrestrial networks (such as Managed cloud or Internet).
There are currently studies with OPAG ISS ET-CTS working group on using Multicast technologies within the WIS. At the moment, it is too early to confirm whether such solution will be available on

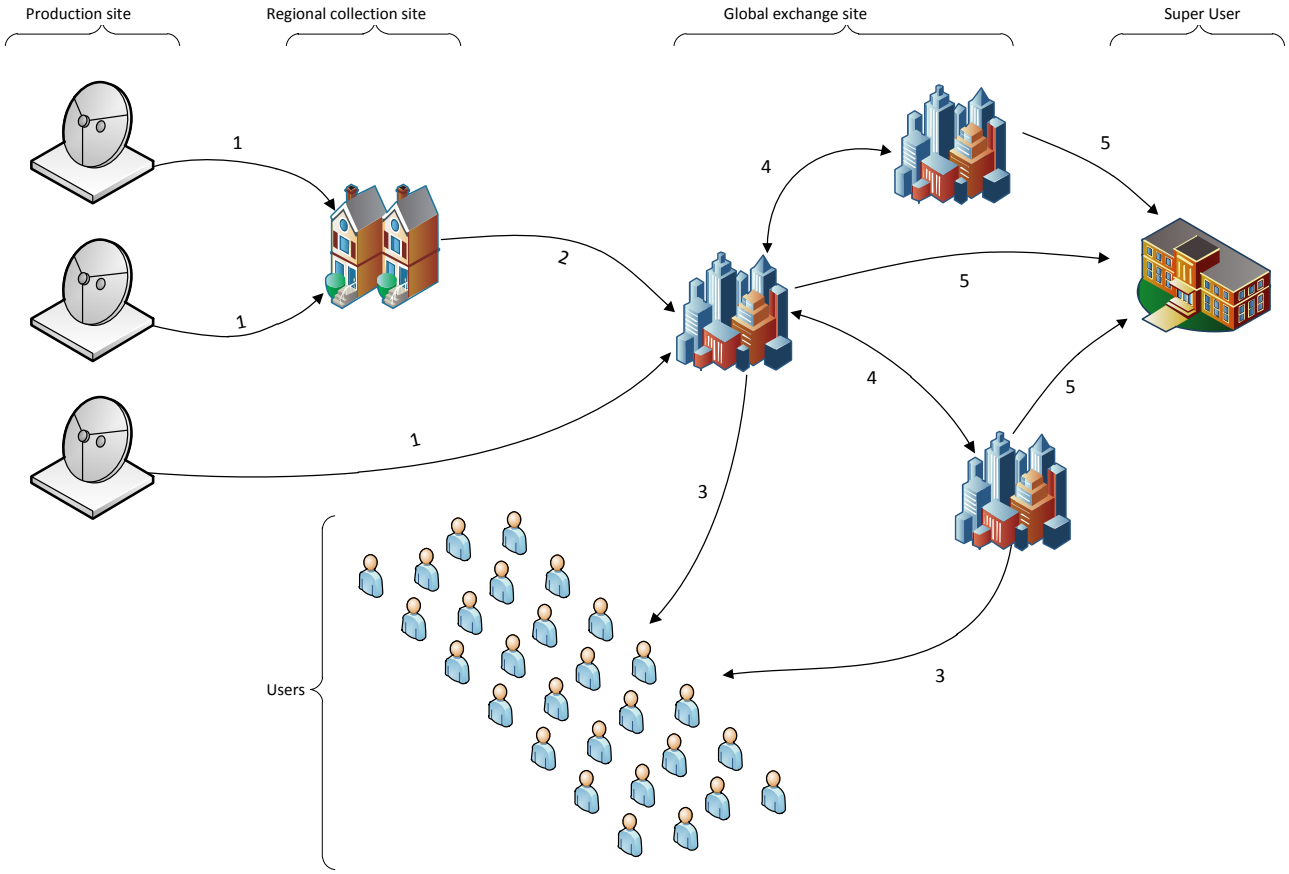
terrestrial network and with which constraints. It must also be noted, that once the technical challenge at the “link layer” is solved, it will also require a standard “application” solution. At the moment, there is only one open source multicast solution available and one commercial product. So, when building the architecture, it is “safer” to assume that only the satellite broadcast can be used as a multicast (or broadcast) technology and that all other solutions are limited to Unicast. It means that if the same product needs to be sent to multiple users, the sending site will have to have enough bandwidth to do as many parallel transfers as required.

On the GTS (Global Telecommunication System) and on the WIS (WMO information System), solutions such as the Message Switching System are used to distribute the same data to multiple destination using an application level routing solution. The product is received once (eg. from a regional centre) and the national centre, based on a “routing table” (each product is identified by its header or by its file name) will then “multicast” the file to multiple destinations. From an application point of view, this is a “multicast” solution, however, as the networking level (except if multicast solution is used), the product will need to be sent as many times as required. Therefore, the bandwidth used at the sending site will be able to support multiple transfers. This is a way to emulate a “multicast” solution onto “unicast” networks.

4. Typical data flows

After having identified the available technologies to exchange data, the next step is to consider the data flows for radar exchanges. These data flows can be represented in picture 2 below.

Picture 3. Typical data flows for radar exchange



On this picture, we have identified 5 types of locations/users:

- Production site, the radar
- A Regional collection site (eg. for very large countries a regional centre gathering local radar data)
- Users (eg. end user)
- A Global exchange site (eg. the national centre for a country)
- A Super User (eg. a NWP site)

Each category of location/site will have a different list of constraints and requirements. The constraints can either be geographic, financial or technical (eg. security) and the requirements will be based on elements such as required performance, reliability or the availability of Service Level Agreements.

5. Summary

Picture 3 above shows the typical data flows related to exchange of radar data. Combining these flows with the technical solutions from Table 1 and their pros/cons of Table 2, it is now possible to match technologies and data flows.

Of course, this would require further analysis but shows where each technology can be considered in designing the solution.

Technology / Flow	Mobile telephony	Satellite broadcast	Satellite upload	Internet	Managed cloud	Private circuit	Dark Fibre
1	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes
2	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes
3	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes
4	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes
5	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes	No Maybe Yes