



Research development of GNSS IDM and suggestion on sharing, dissemination, standardization of interference info

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Only Represent Personal Views

Presentation Overview

- I. Research of identifying natural and non-natural interference
- II. Suggestion on sharing, dissemination & standardization of interference information

I Research of identifying natural and non-natural interference

Classification of interference sources

- Sources of Interference includes:

- Intentional Emitters
- Unintentional Emitters
- Natural Disturbances

- Present understanding of unintentional interference *from the Proposed Workshop*

Agenda: Unintentional interference arises from electronic devices which emit at or near the frequency spectrum of GNSS signals.

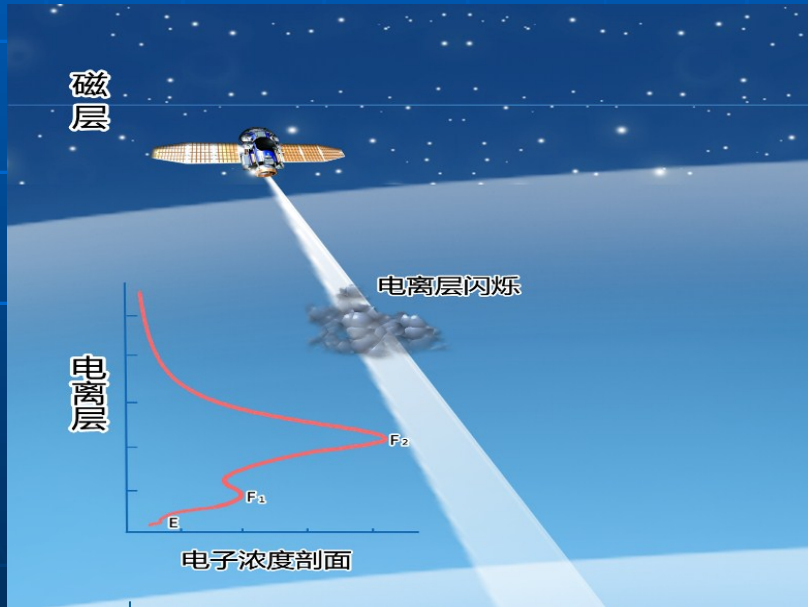
- It is **advised** to change to: Unintentional interference arises from electronic devices which emit at or near the frequency spectrum of GNSS signals, or at other bands (Harmonics, intermodulation etc.), which may degrade the reception of GNSS signals.

● Natural Disturbances

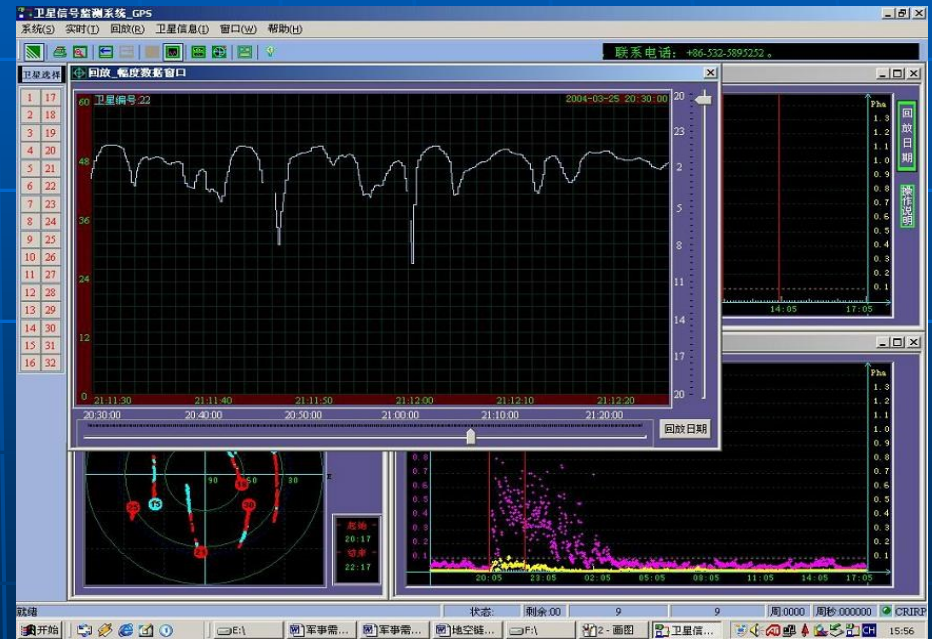
➤ Space weather environment means all the factors which may have effect on the propagation of satellite radio signals.

● Natural Disturbances – ionospheric scintillation

➤ Ionospheric scintillation will cause dramatic decrease of quality of receiving signal, and affect the accuracy of GNSS positioning.

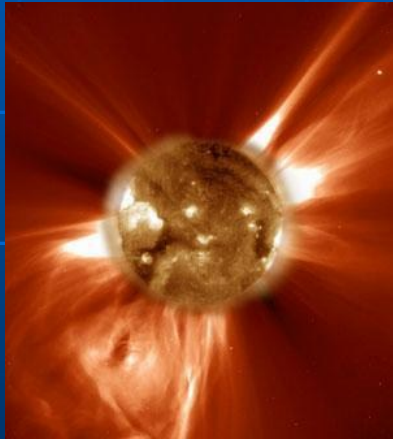


Sketch map of ionospheric scintillation

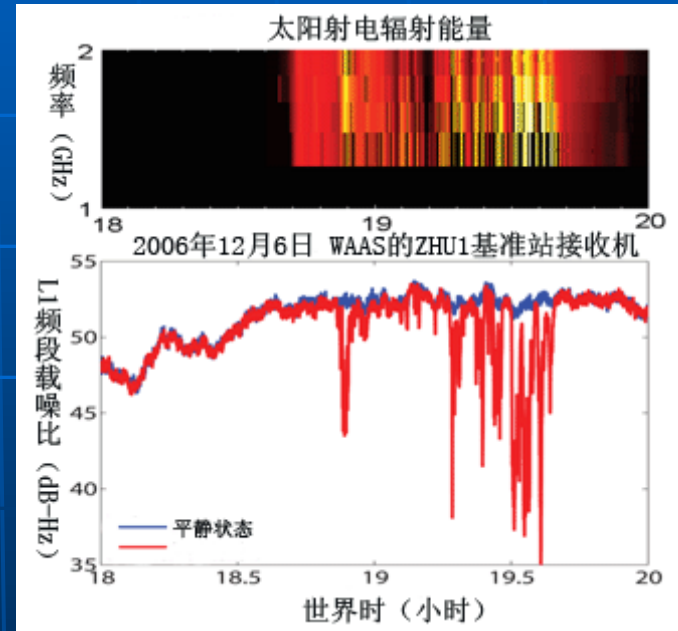


Natural Disturbances
(Ionospheric scintillation)

● Natural Disturbances – solar radio noise



Solar burst



solar radio noise cause decrease S/N of GNSS signal

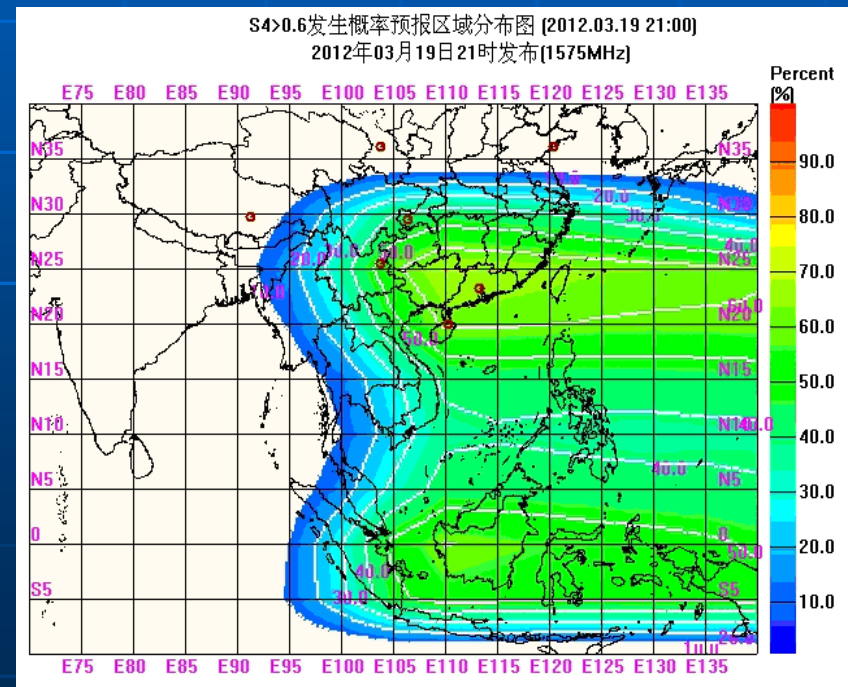
Identifying natural and non-natural interference

- Distinguishing between natural and non-natural interference is an important component of interference detection and mitigation.
- It needs comprehensive understanding of information from multi sources and can be realized from different level.

Identifying natural and non-natural interference

1) System level

- To get information from space environment monitoring network for GNSS, and to distribute parameters of space environment which may have effects on GNSS system
- Available GNSS monitoring network (such as IGS) can also be used to assist analysis of interference distinguish.

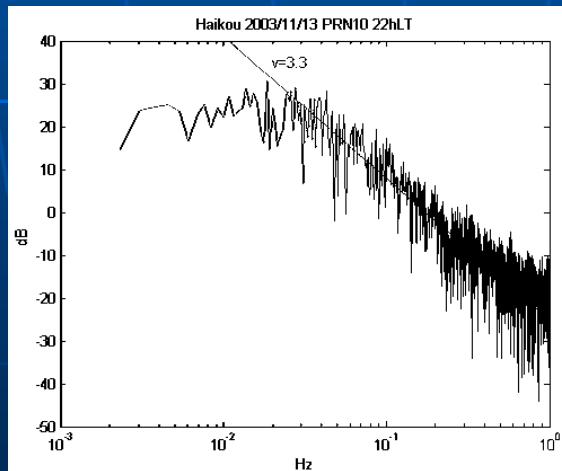


Distribution of ionospheric scintillation effects

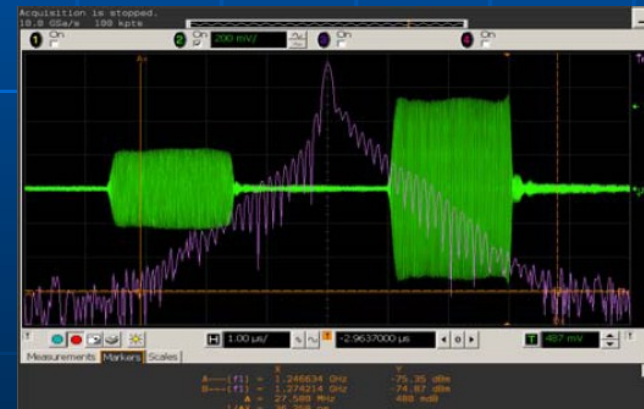
Identifying natural and non-natural interference

2) Receiver level

- Professional interference monitoring device can be developed to detect and differentiate the natural and non-natural interference.
- Some different characteristics between natural and non-natural interference:
 - ✓ Size of affected region
 - ✓ Spectrum of affected signal



Spectrum of scintillation



Interference from radar signal

II. Suggestion on standardization, sharing and dissemination interference information

2.1 suggestion on standardization of interference information

2.1.1 Standardization of users information

2.1.2 Standardization of interference event information

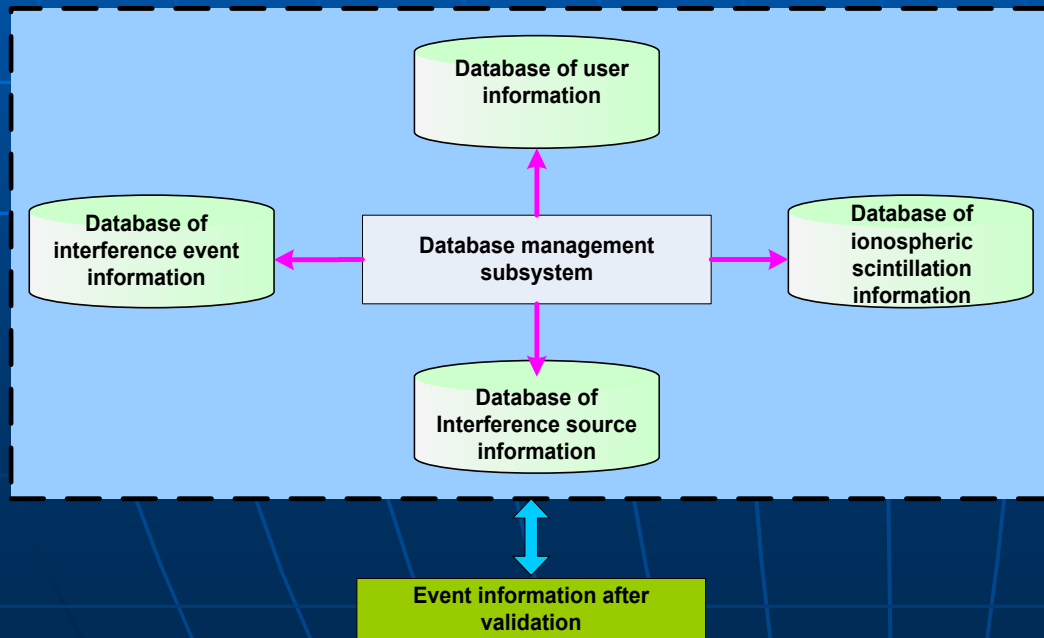
2.1.3 Standardization of interference source information

2.2 Suggestion on sharing of interference information

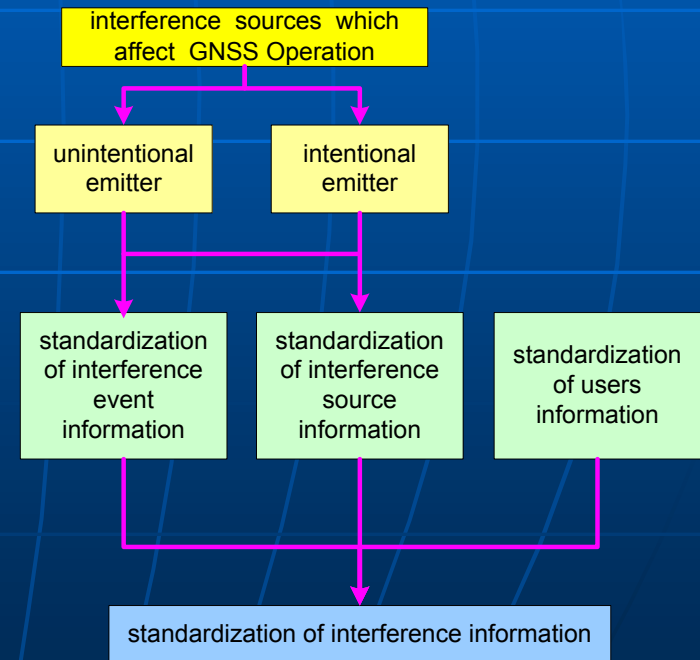
2.3 Suggestion on dissemination of interference information

2.1 suggestion on standardization of interference information

- The interference sources:
 - Non natural emitters: unintentional and intentional emitter.
 - Natural disturbances: ionospheric scintillation and solar radio noise, etc.
- Standardization of interference information shall include:
 - Standardization of users information
 - Standardization of interference event information
 - Standardization of interference source information



Interference monitoring database system



Standardization of interference information

2.1 suggestion on standardization of interference information

2.1.1 Standardization of users information

- Users information: identity and contact info of user for interference reporting. The users include critical user and general user. Requirements for information input and query is different for different type of users.

Parameters of user info

No.	Data field	options	Remarks
1	Registered name	Name of company or person	
2	Users type	general GPS user, critical GPS user general BD user, critical BD user	Can be expanded to Galileo and GLONASS in future
3	ID number of registered user	Only for personal user	
4	Name of contact person		
5	Mobile of contact person		
6	Phone of contact person		
7	Email		
8	Address		
9	Remarks		

2.1 suggestion on standardization of interference information

2.1.2 Standardization of interference event information Information of interference event include:

- Spatial and temporal info of event
- State info of interfered object
- Ionospheric scintillation and solar radio noise information:

Parameters of interference event

No.	Data fields	Options	Remarks
1	GNSS interfered	GNSS (GPS/BD) anomaly	Can be expanded to Galileo and GLONASS in future
2	Version		
3	Users interfered	<ul style="list-style-type: none"> ● general GPS user, important GPS user ● general BD user, important BD user 	
4	Report time		selected by control
5	Event ID		managed by server
6	Signals interfered	<ul style="list-style-type: none"> ● GPS: L1/L1C/L2/L2C/L5; ● BD: B1/B2/B3; 	Info. shared only for civil code
7	State of the receiving signal	loss of all satellites/ failure of timing /failure of positioning /loss of part satellites	Not limited to one option
8	State of satellite signal	<ul style="list-style-type: none"> ● C/N: stable/ increase/decrease/unknown ● Amplitude: stable/ increase/decrease/unknown ● Phase: stable/jitter/ unknown 	
9	Location info	XX town (road), XX district, XX city, XX Province	selective
10	Spatial distribution of interference event	ground/ air/space/unknown	
11	Spatial state of interference event	static/ varying/ increasing/decreasing/unknown	
12	Time distribution of interference event	continuous/ periodical/random/unknown	
13	State of the interfering event	stopped/ continuing	
14	Polar diagram of antenna	Omni directional/ directional/ unknown	
15	Location interfered	Latitude, longitude	
16	Interference Event time	Start time, stop time	
17	Scintillation time	Start time, end time	
18	Scintillation intensity index	S4	
19	Scintillation phase index	σ_{ϕ}	
20	Remarks	The info that is not mentioned can be detailed in remarks.	

2.1 suggestion on standardization of interference information

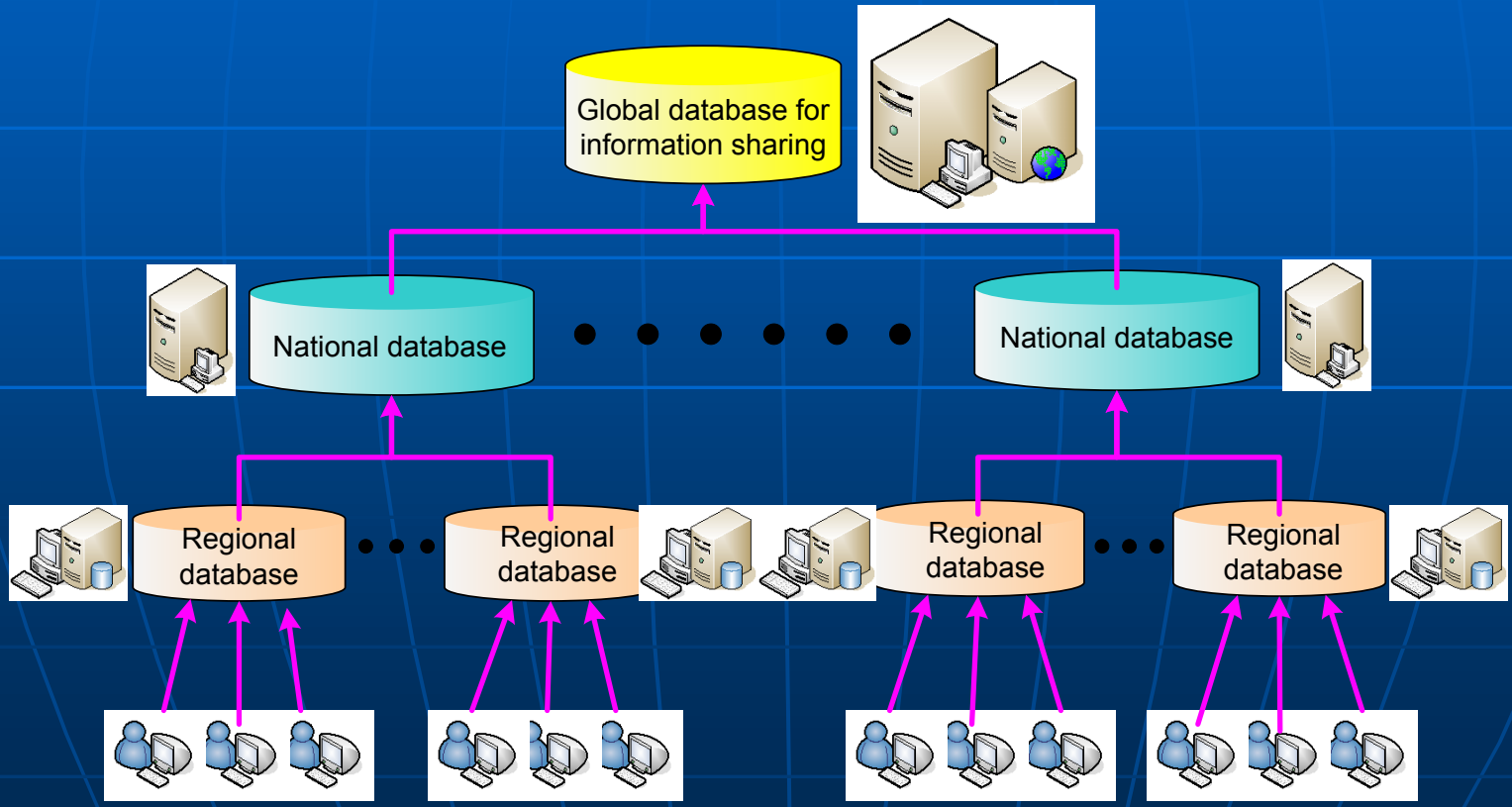
2.1.3 Standardization of interference source information

Standard parameter info for interference source

No.	Data fields	Options	Remarks
1	type of Event	GNSS (GPS/BD) anomaly	Can be expanded to Galileo and GLONASS in future
2	Version		
3	Users interfered	<ul style="list-style-type: none">● general GPS user, important GPS user● general BD user, important BD user	
4	Report time		selected by control
5	Event ID		managed by server
6	Central frequency of interfering signal	1575.42MHz	unit should be fixed, value can be selected
7	Bandwidth of interfering signal	5MHz	unit should be fixed, value can be selected
8	modulation of interfering signal	CW/AM/LSB/USB/FM/FSK/PSK/ASK/unknown	classical modulation types shall be totally listed
9	Power of interferer	10dBm	unit should be fixed, power of the receiving point
10	band of the interfering signal	1550MHz-1551MHz	unit should be fixed
11	direction of interfering	300degree (start from the north, clockwise)	inclination at the point of interfered
12	Location of the interferer	Latitude, longitude	After searching and identified
13	characteristics of interferer	frequency/power/bandwidth/modulation	
14	type of interferer	same band/ neighbor band/other	the actual working band of the interferer
15	Remarks	The info that is not mentioned can be detailed in remarks.	

2.2 Suggestion on sharing of interference information

- GNSS users can input interference info by internet to form regional and national interference information database.
- Data from the regional and national database will be reported to the global database for information sharing after validation and filtered.



Global interference information sharing

2.2 Suggestion on sharing of interference information

1) Register and validation of user

Registration can be in two ways:

- By internet
- By telephone

The ID validation includes:

- Validation of register info: For general user and critical user, the reality of their info need to be validated.
- Validation of login info.

2) Collection and storage of reported info

- The interference info from user will be validated and stored in the interference monitoring database.
- The recording info include interference event info and interference source info.

3) Validation and filter to produce global sharing information

2.2 Suggestion on sharing of interference information

3) Validation and filter to produce global sharing information

In order to guarantee the accuracy and reliability, interference info from different state and country will be filtered and validated before sending to the global database for information sharing.

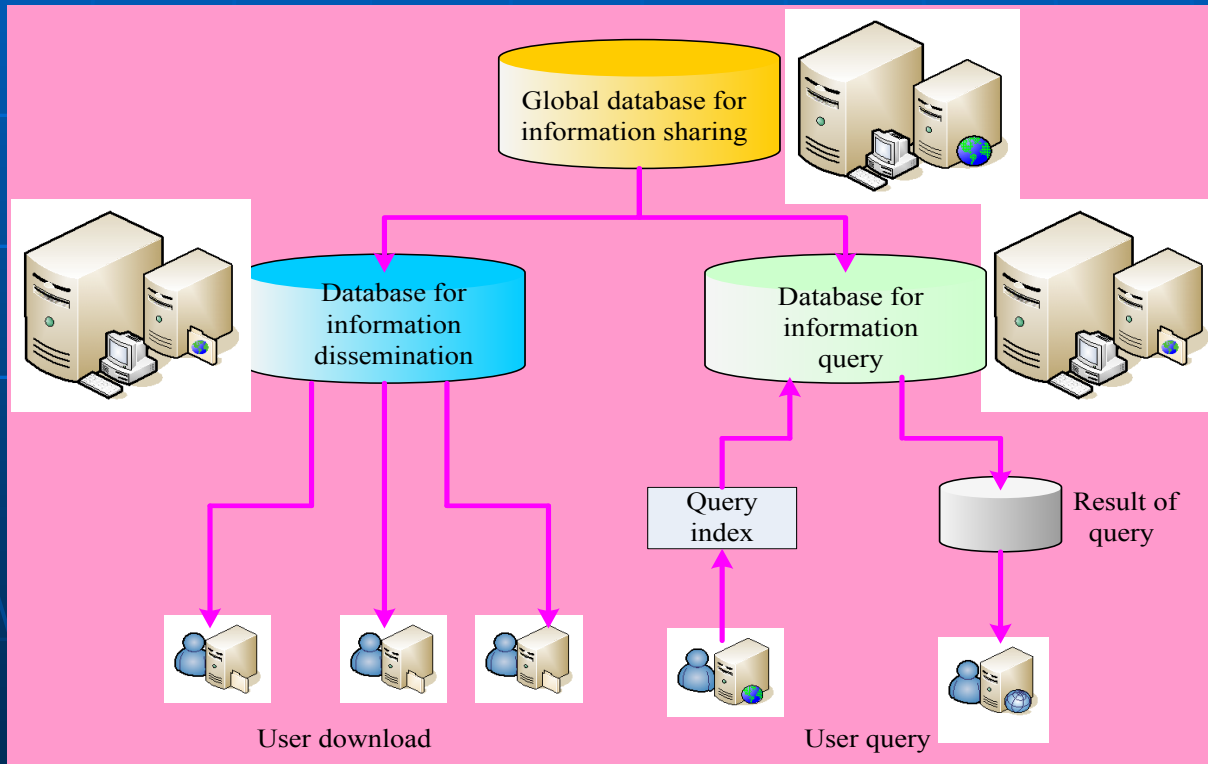
- Procedure for validation of interference info:

- Validate the reported info by telephone and email;
- Compare multiple reported event;
- Detect and identify of interference source by professional agencies.

- All the related information will be updated and sent to the global database during the process of analysis and mitigation of interference.

2.3 Suggestion on dissemination of interference information

Registered user can query by internet the information what he concerns about the interference event.



Global dissemination of interference information

2.3 Suggestion on dissemination of interference information

Dissemination of interference info includes:

- 1) Query of interference info: User submit the requirements of query, corresponding data will be extracted from interference database by the information preparation subsystem.
- 2) Dissemination and download of interference info: User download info disseminated by the system according to its own requirements.



**Thank you for
your attention!**

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