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Re:	IEEE 802.16j-06/034: “Call for Technical Proposals regarding IEEE Project P802.16j”	
Abstract	This contribution proposes procedures for RS location report for neighbor discovery	
Purpose	Text proposal for 802.16j Baseline Document	
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RS Location Report for Neighbor Discovery

Coordination Definition in Location Report Message

Global navigation satellite system (GNSS) is the generic name given to the satellite-based navigation systems including GPS (global positioning system), GLONASS (global navigation satellite system), and Galileo. GPS is the first passive one-way ranging satellite system to be-come operational. While GPS was under development by United States (US), the Soviet Union undertook to develop a similar system, called GLONASS. Like GPS, GLONASS was designed primarily for the military, and was also offered for civil use. In a later time, the European Un-ion decided to develop a similar system planed to under civil control. This system is called Galileo, which is now developed by European Space Agency (ESA).

The World Geodetic System (WGS) defines a fixed global reference frame for the Earth, for use in geodesy and navigation. The latest revision is WGS 84 dating from 1984 (last revised in 2004), which will be valid up to about 2010.

ECEF stands for Earth-Centered, Earth-Fixed, and is a Cartesian coordinate system used for GPS. It represents positions as an X, Y, and Z coordinate in meters. The point (0,0,0) denotes the center of the earth, hence the name Earth-Centered.

Local Tangent Plane (LTP) is also known as North East Down (NED). It is a geographical coordinate system for representing state vectors that is commonly used in aviation. It consists of three numbers, one represent the position along the northern axis, one along the eastern axis, and one representing vertical position. Down is chosen as opposed to up in order to comply with the right-hand rule.

Convert ECEF WGS 84 to LTP coordination

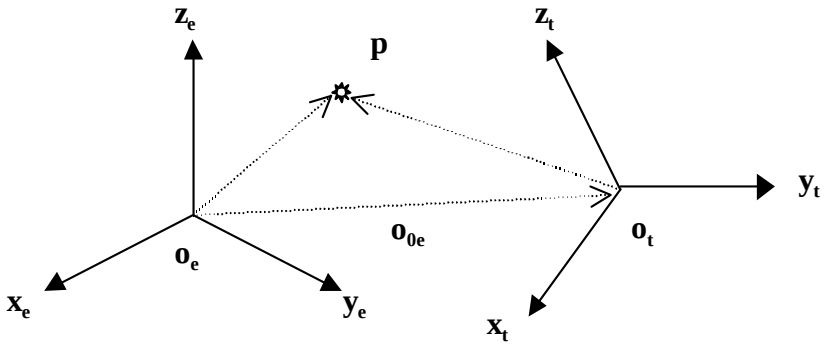


Figure 1. Convert ECEF WGS 84 to LTP Coordination

In figure 1, O_e and O_t (= $[x_{oe}\ y_{oe}\ z_{oe}]^T$) are the original point of the WGS-84 and LTP coordination respectively. Then we could convert position from ECEF WGS-84 to LTP through the following equation

$$\begin{bmatrix} x_t \\ y_t \\ z_t \end{bmatrix} = \mathbf{R}_{\mathbf{e2t}} \left(\begin{bmatrix} x_e \\ y_e \\ z_e \end{bmatrix} - \begin{bmatrix} x_{0e} \\ y_{0e} \\ z_{0e} \end{bmatrix} \right)$$

where

x_t: east direction axis

y_t: north direction axis

z_t: down direction axis

ϕ: longtitude of O_t

λ: latitude of O_t

$\mathbf{R_{e2t}}$: Matrix for converting WGS-84 to LTP coordination is defined as follows

$$
\begin{aligned}
\mathbf{R}_{\mathbf{e2t}} &= \mathbf{R}_{\mathbf{x}}\left(\frac{\pi}{2}-\lambda\right)\mathbf{R}_{\mathbf{z}}\left(\frac{\pi}{2}+\phi\right) \\
&= \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\left(\frac{\pi}{2}-\lambda\right) & \sin\left(\frac{\pi}{2}-\lambda\right) \\ 0 & -\sin\left(\frac{\pi}{2}-\lambda\right) & \cos\left(\frac{\pi}{2}-\lambda\right) \end{bmatrix} \begin{bmatrix} \cos\left(\frac{\pi}{2}+\phi\right) & \sin\left(\frac{\pi}{2}+\phi\right) & 0 \\ -\sin\left(\frac{\pi}{2}+\phi\right) & \cos\left(\frac{\pi}{2}+\phi\right) & 0 \\ 0 & 0 & 1 \end{bmatrix} \\
&= \begin{bmatrix} 1 & 0 & 0 \\ 0 & \sin(\lambda) & \cos(\lambda) \\ 0 & -\cos(\lambda) & \sin(\lambda) \end{bmatrix} \begin{bmatrix} -\sin(\phi) & \cos(\phi) & 0 \\ -\cos(\phi) & -\sin(\phi) & 0 \\ 0 & 0 & 1 \end{bmatrix} \\
&= \begin{bmatrix} -\sin(\lambda) & \cos(\phi) & 0 \\ -\sin(\lambda)\cos(\phi) & -\sin(\lambda)\sin(\phi) & \cos(\lambda) \\ \cos(\lambda)\cos(\phi) & \cos(\lambda)\sin(\phi) & \sin(\lambda) \end{bmatrix}
\end{aligned}
$$

Conclusion

This contribution describes RS location report for neighbor discovery. In order to facilitate the incorporation of this proposal into IEEE 802.16j standard, specific changes to the baseline working document IEEE 802.16j-06/026r1 are listed below.

Text Proposal

6.3.26 Relay station neighborhood discovery

Insert new subclause as follows

6.3.26.1 RS Location Report

In order to assist RS neighborhood discovery, MR-BS should send an RLY_LOC_REP-REQ message defined in Table xxx. RLY_LOC_REP-REQ message should include reference location and may include report repetition interval.

After RS receives the RLY_LOC_REP-REQ message, RS shall update its reference location if the message includes a valid reference location. Then, RS shall report the deviation from the reference location by transmitting an RLY_LOC_REP-RSP message to the serving MR-BS. If the RLY_LOC_REP-REQ message includes a nonzero Report Repetition Interval, RS shall periodically send an RLY_LOC_REP-RSP message to

the serving MR-BS every time interval defined by Report Repetition Interval.

Upon receiving the RLY_LOC_REP-RSP message from an RS, the serving MR-BS may send an RLY_NBR-REP message to the RS, which contains the location information and CellID of neighbor RSs.

The message sequence charts (Table xxx and Table yyy) and flow charts (Figure xxx and Figure yyy) define the RS location report process that shall be followed by compliant RSs and MR-BSs.

Table xxx – RLY_LOC_REP-REQ message format

Syntax	Size	Notes
RLY_LOC-REP_Message_Format() {	-	-
Management message type = xx	8 bits	-
TLV Encoded Information		
}		

Table xxx –RLY_LOC_REP-REQ message encodings

	Type (1 byte)	Length	Value (Variable-length)	PHY Scope
Report Repetition Internal	TBA	1	Repetition Internal for RLY_LOC_REP-RSP (unit: frame)	OFDMA
Reference Location in WGS84	TBA	12	Byte 11:8 – Rx: X-axis reference position in Earth Centered Earth Fixed (ECEF) WGS84 (unit: meter) Byte 7:4 – Ry: Y-axis reference position in Earth Centered Earth Fixed (ECEF) WGS84 (unit: meter) Byte 3:0 –Rz: Z-axis reference position in Earth Centered Earth Fixed (ECEF) WGS84 (unit: meter)	OFDMA

Table xxx – RLY_LOC_REP-RSP message format

Syntax	Size	Notes
RLY_LOC_REP-RSP_Message_Format() {	-	-
Management message type = xx	8 bits	-
FSN	8 bits	8-bit LSB frame sequence number for estimated position
Px	18 bits	Estimated RS X-axis position deviation from the reference in Local Tangent Plane (LTP) (unit: meter)
Py	18 bits	Estimated RS Y-axis position deviation from the reference in Local Tangent Plane (LTP) (unit: meter)
Pz	12 bits	Estimated RS Z-axis position deviation from the reference in Local Tangent Plane (LTP) (unit: meter)
If (LOC-REP type = 01) {		
FSN offset	8 bits	8-bit frame sequence number deviation from the FSN

		(unit: frame)
PPe	9 bits	Predicted RS east-axis position deviation from the estimated position in Local Tangent Plane (LTP) (unit: meter)
PPn	9 bits	Predicted RS north-axis position deviation from the estimated position in Local Tangent Plane (LTP) (unit: meter)
PPd	6 bits	Predicted RS down-axis position deviation from the estimated position in Local Tangent Plane (LTP) (unit: meter)
} else {		
If (LOC-REP Type = 10 or 11) {		
Ve	9 bits	RS east-axis velocity in Local Tangent Plane (LTP) (unit: (TBD) centimeter/second)
Vn	9 bits	RS north-axis velocity in Local Tangent Plane (LTP) (unit: (TBD) centimeter/second)
Vd	6 bits	RS down-axis velocity in Local Tangent Plane (LTP) (unit: (TBD) centimeter/second)
}		
If (LOC-REP type = 11)		
Ae	9 bits	RS east-axis acceleration in Local Tangent Plane (LTP) WGS84 (unit: (TBD) millimeter/second^2)
An	9 bits	RS north-axis acceleration in Local Tangent Plane (LTP) WGS84 (unit: (TBD) millimeter/second^2)
Ad	6 bits	RS down-axis acceleration in Local Tangent Plane (LTP) (unit: (TBD) millimeter/second^2)
}		
}		
}		

Table xxx – RLY_NBR-REP message format

Syntax	Size	Notes
RLY_NBR-REP_Message_Format() {	-	-
Management message type = xx	8 bits	-
Frame sequence number (FSN)	16 bits	Frame sequence number for estimated position
Nr. of neighbor AS	-	Number of neighbor Access Station
for (i=0; i< Nr. of neighbor AS; i++) {	-	-
Reserved	1 bits	Shall be zero
Preamble Index of RS	7 bits	Preamble Index of RS

}	-	-
}	-	-

Insert new subclause as follows

11.7.20 capabilities encodings

11.7.20.1 Location Report Support

	Type (1 byte)	Length	Value (Variable-length)	Scope
Location Report Support	TBA	1	Bit 0: Location Report Support 0: did not support location report 1: support location report Bit 1~2: Positioning Type 00: fix position (for fix or portable relay) 01: GPS/Galileo positioning 10: GLONASS positioning 11: reserved Bit 3~4: LOC-REP Type 00: report fix/estimated position only 01: report estimated location with predicted position 10: report estimated location with estimated velocity 11: report estimated location with estimated velocity and acceleration Bit 5~7: reserved	SBC-REQ

Table xxx: Relay location report (part 1)

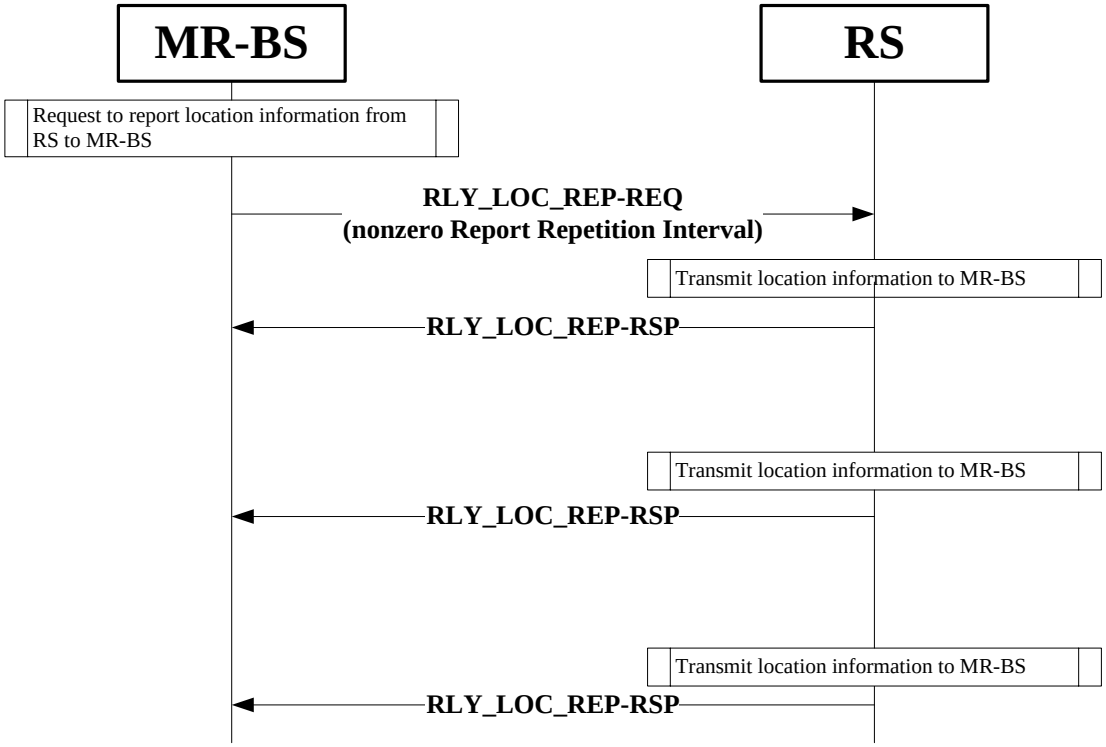
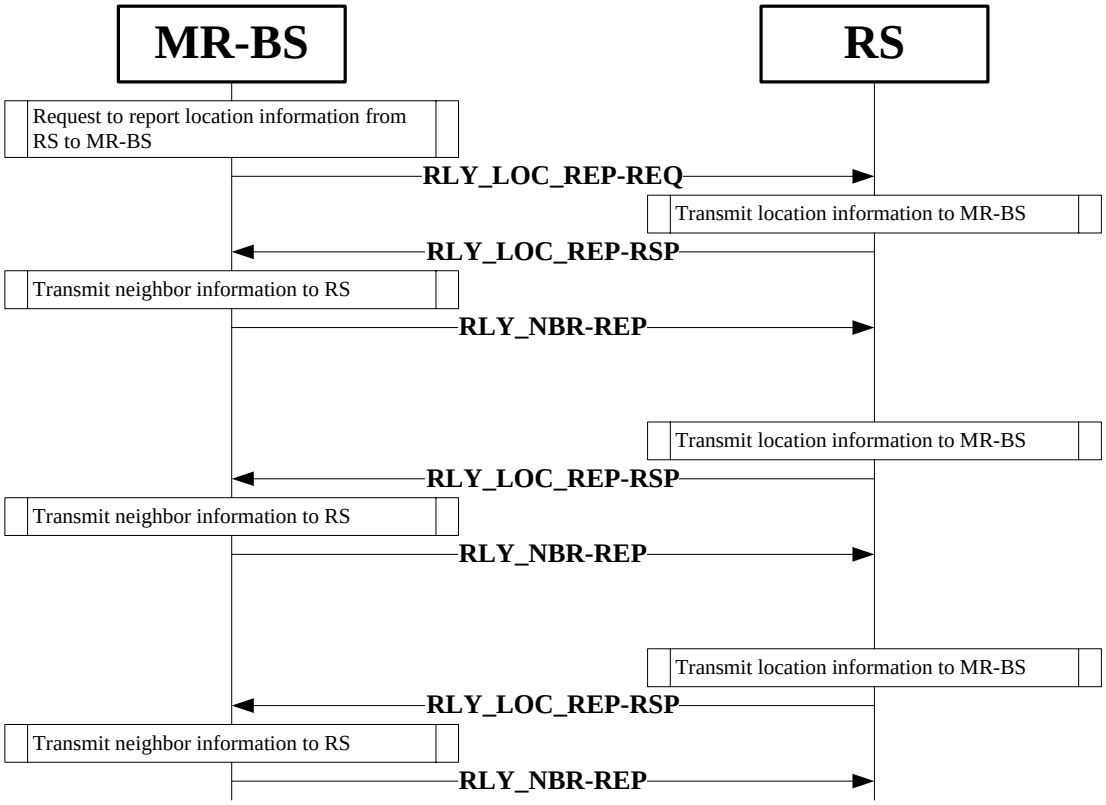


Table yyy: Relay location report (part 2)



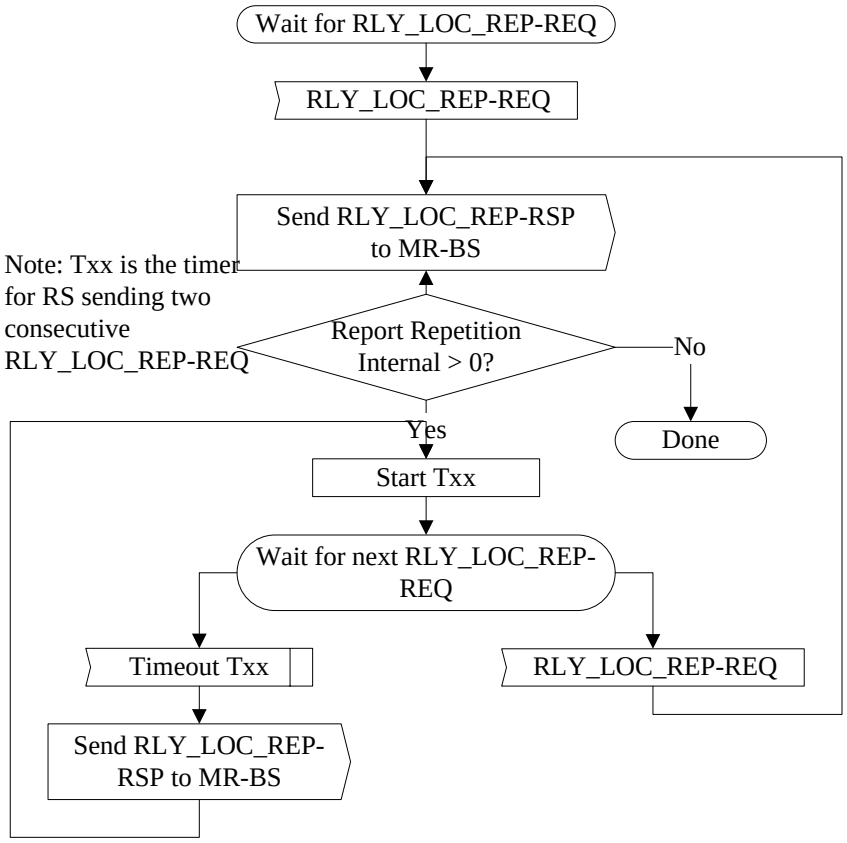


Figure xxx Relay location report- RS

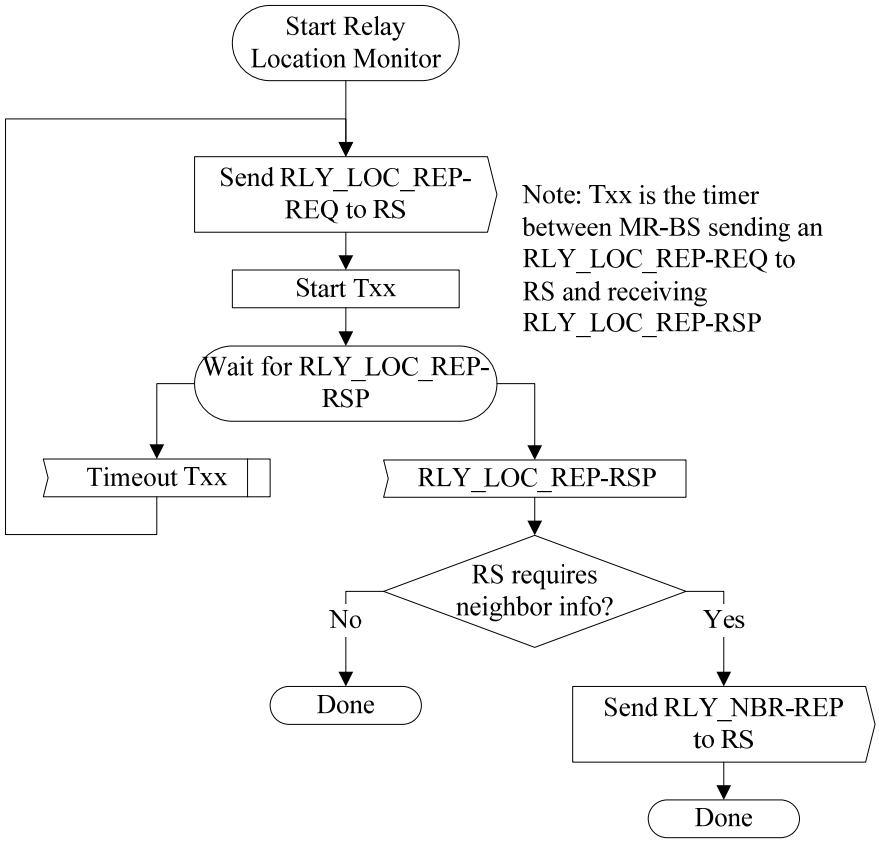


Figure yyy Relay location report – MR-BS