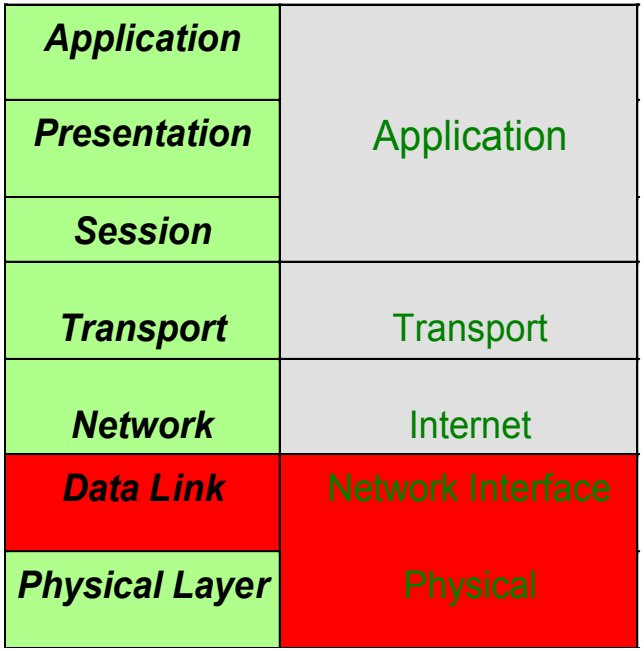
Handover and Call Control



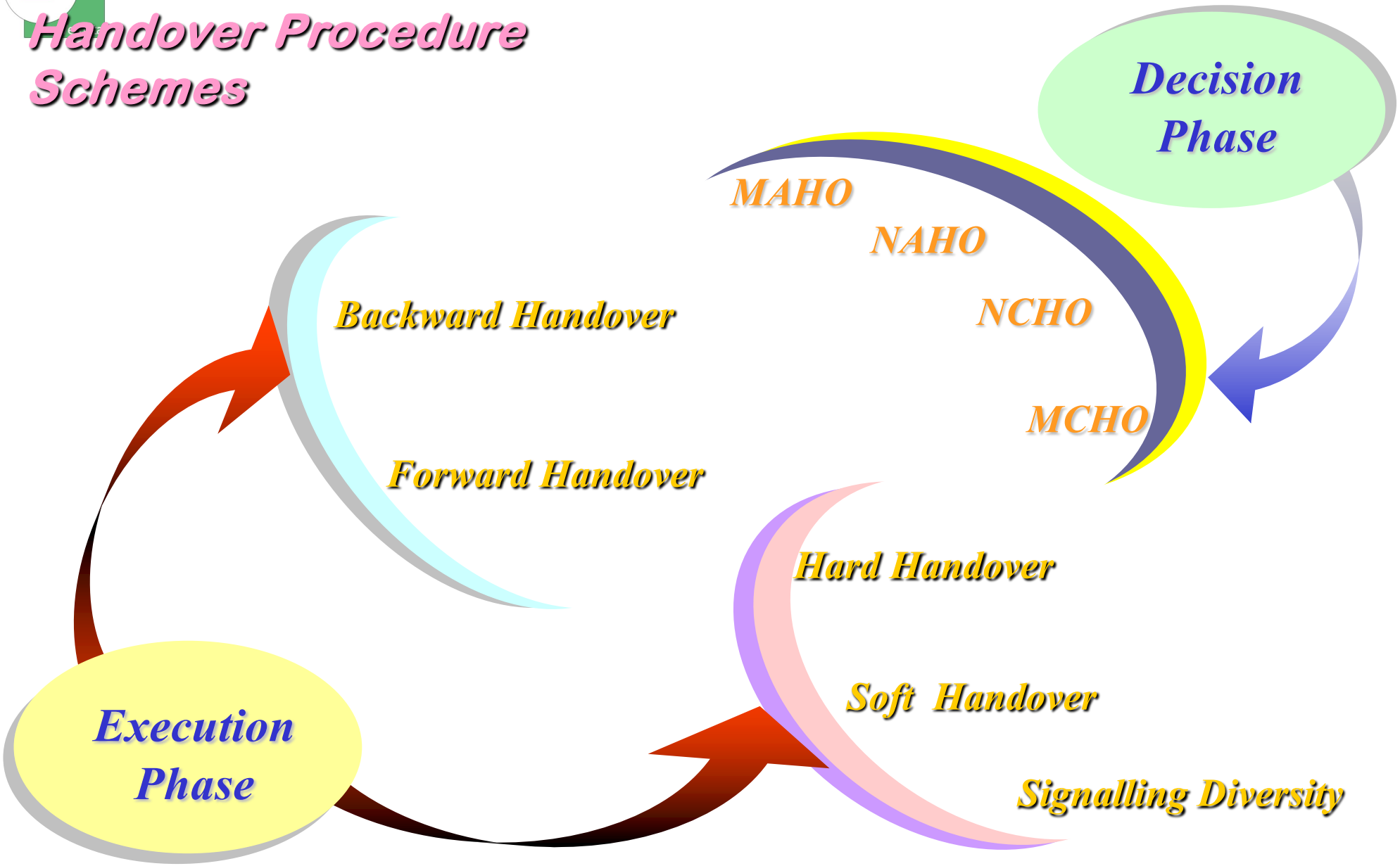
Handover generalities

- In the case of relative motion between satellites and users the link geometry variation imposes the dynamic modification of active connections, i.e. handover.
- Different types of handover:
  - Handover between satellites
  - Handover between on-board spots
  - Handover between GESs
  - Handover between segments (chapter 15)

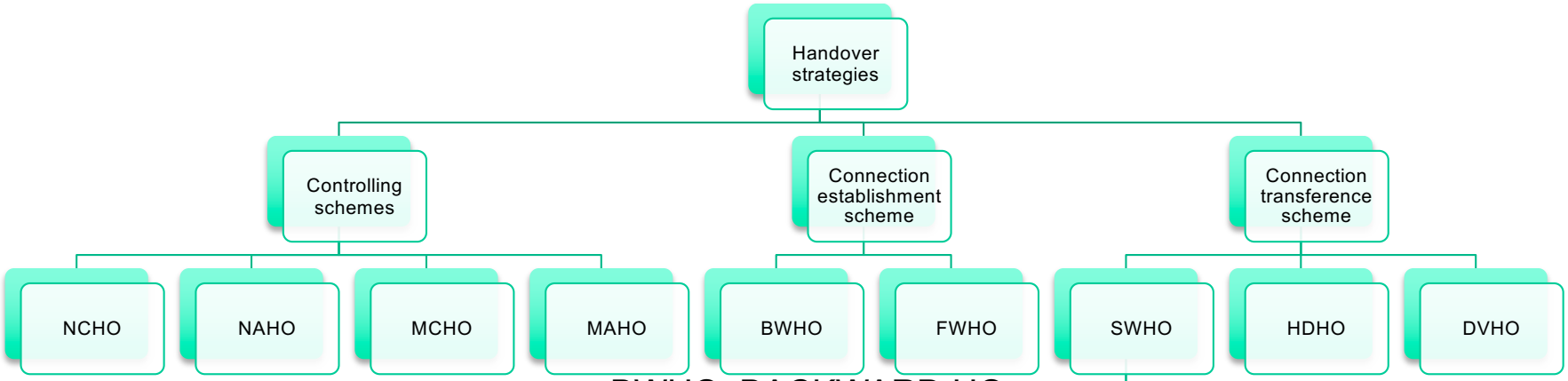
	Mean (s)	Minimum (s)
Iridium	278	10
Globalstar	485	21

Handover between satellites

Handover Procedure Schemes



HANDOVER STRATEGIES



MAHO: MOBILE ASSISTED HO
MCHO: MOBILE CONTROLLED HO
NAHO: NETWORK ASSISTED HO
NCHO: NETWORK CONTROLLED HO

BWHO: BACKWARD HO
FWHO: FORWARD HO

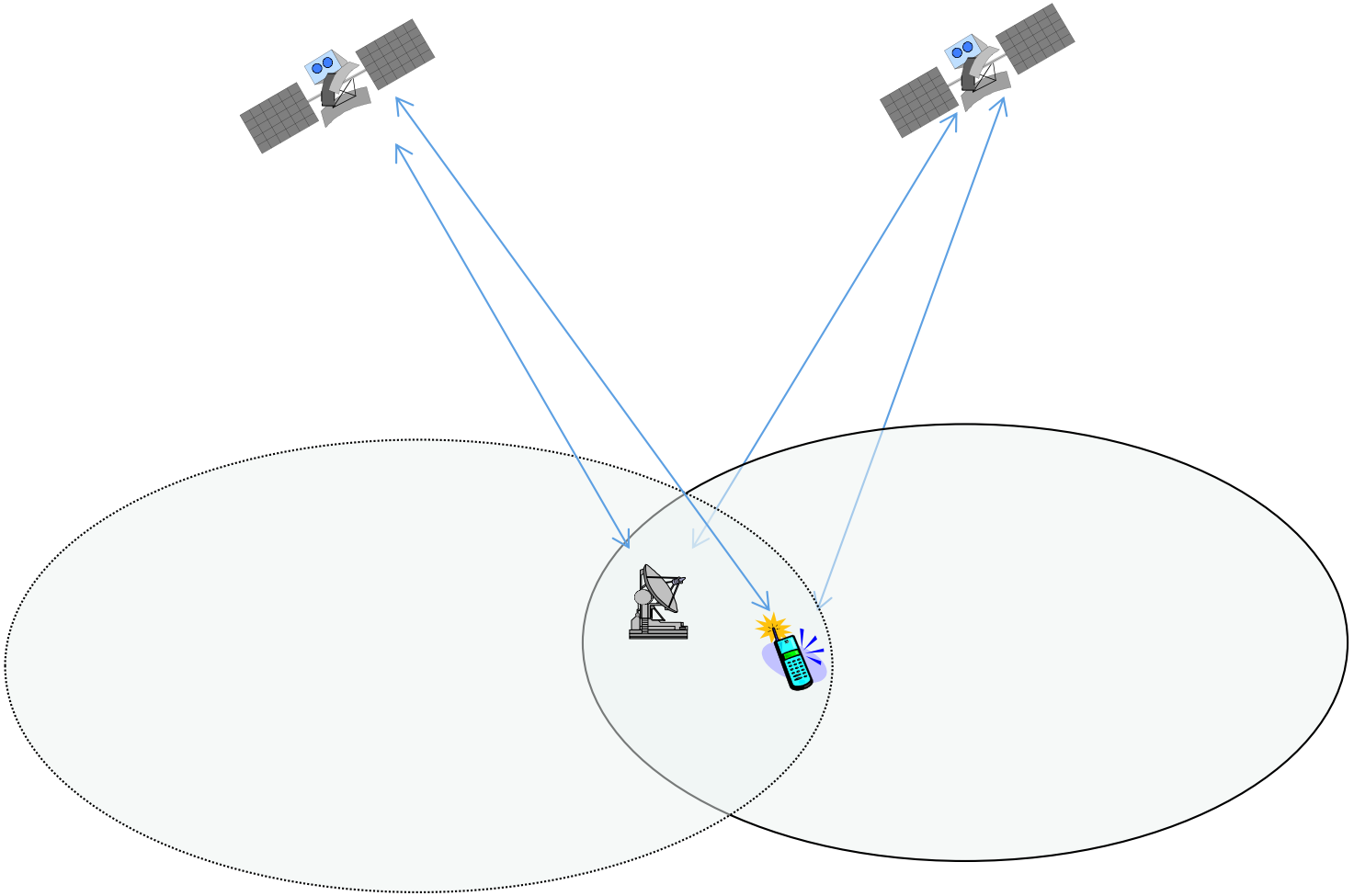
SWHO: SOFT HO
HDHO: HARD HO
DVHO: DIVERSITY HO

SWHO: SWITCHED HO
CBHO: COMBINED HO

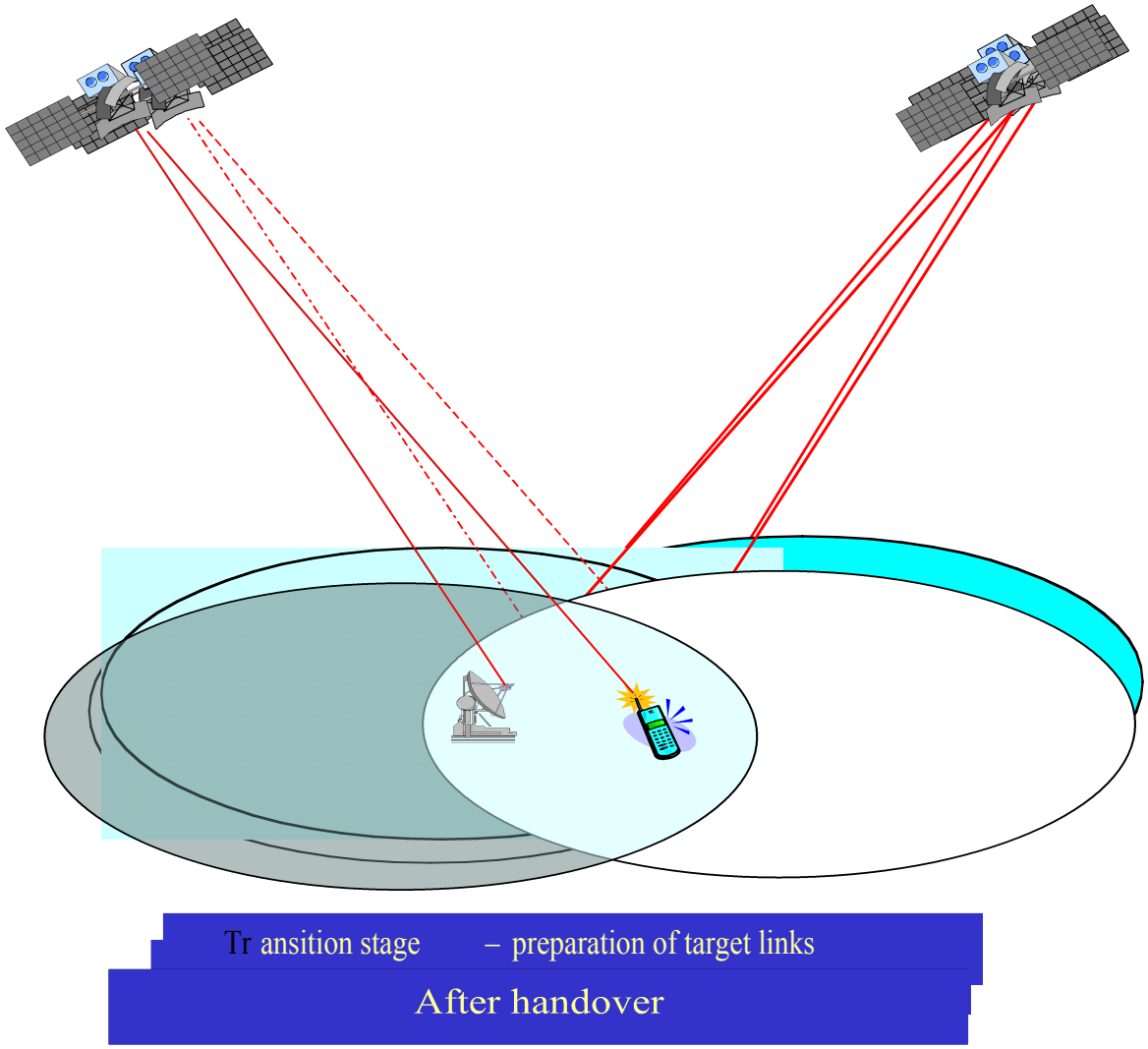
Characteristics of handover controlling schemes

	MCHO	NCHO	MAHO	NAHO
Handover process	Centralized	Centralized	Decentralized	Decentralized
Terminal complexity	High	Low	Moderate	High
Speed of handover	Fast	Fast	Slow	Slow
Signaling load	Low	Low	High	High
Reliability	Moderate	Moderate	High	High

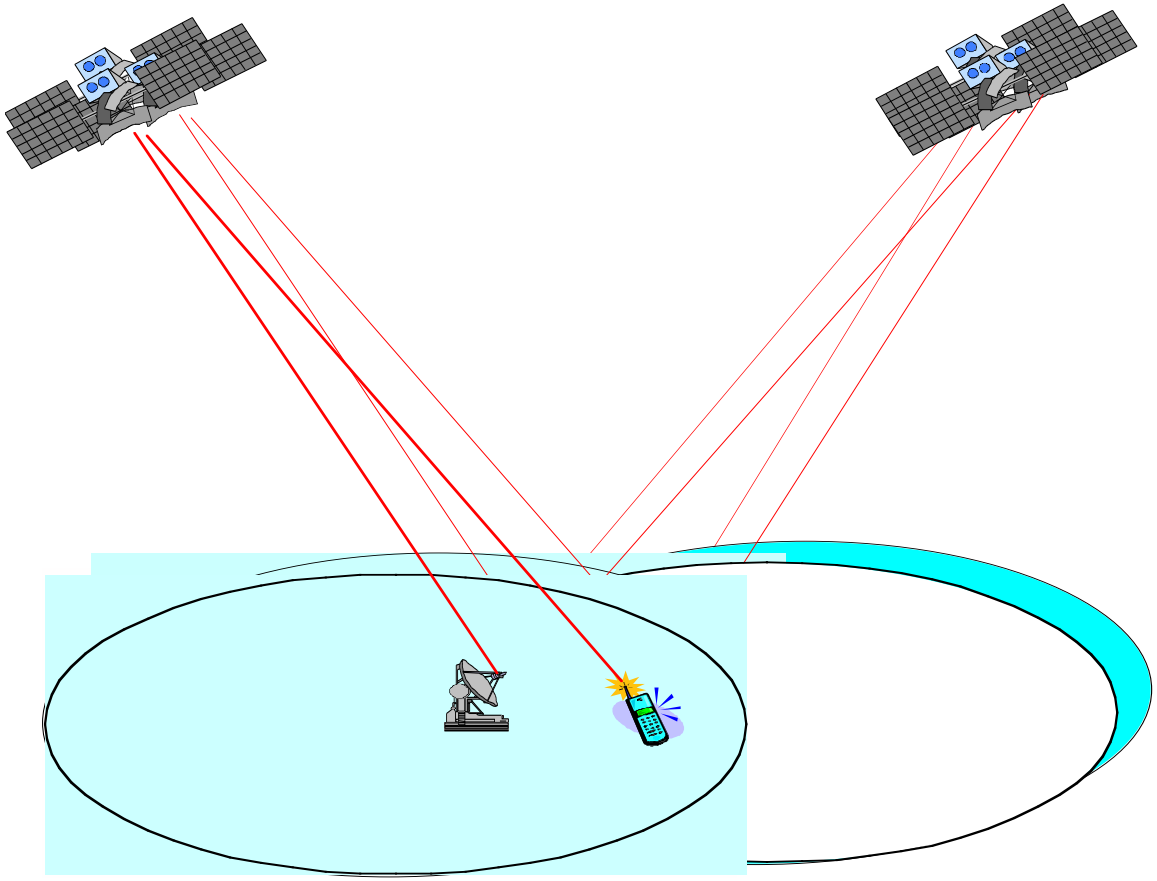
Hard handover



Soft Handover- Switched diversity HO

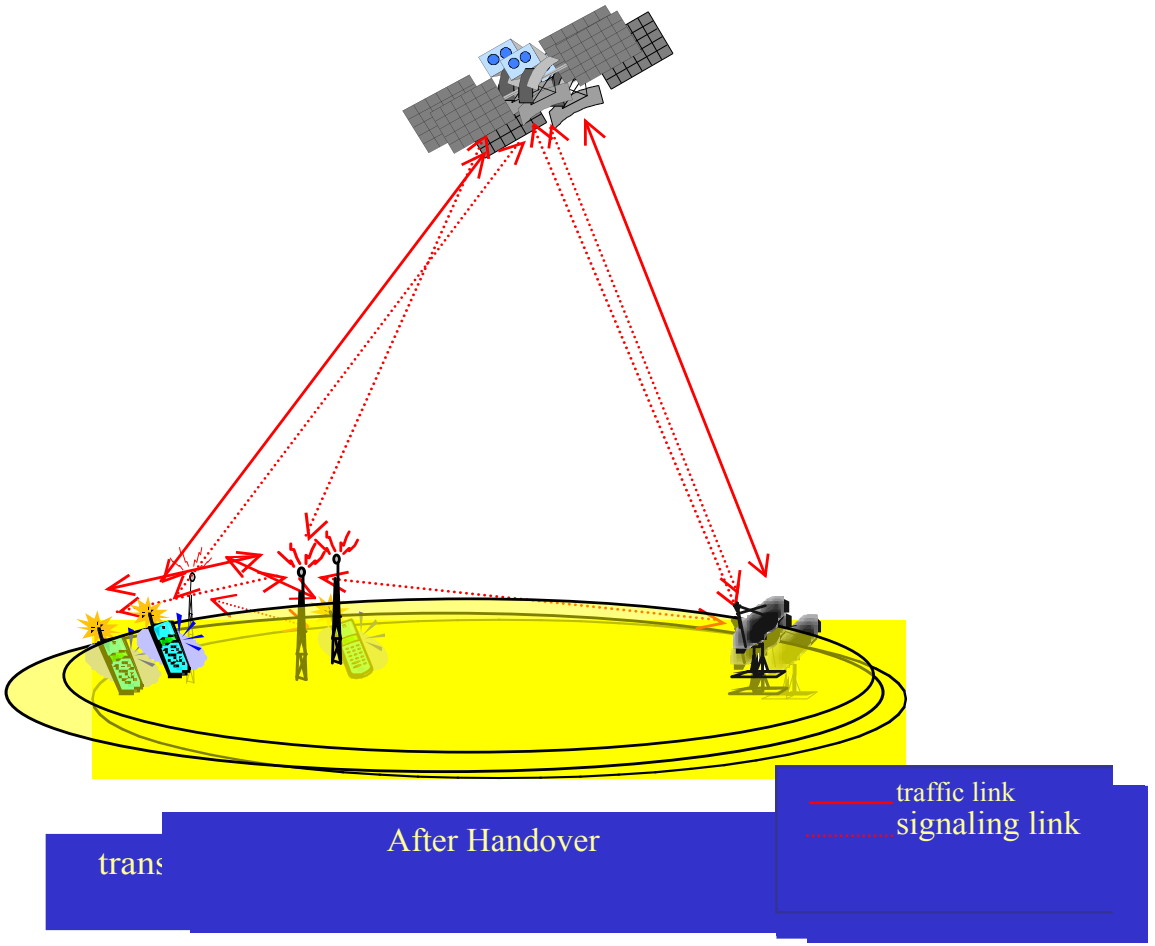


Soft Handover- combined diversity HO



After handover

Signalling Diversity



HO and constellations

	GEO		HEO		MEO		LEO	
User Typology	**Mobile**	**Fixed**	**Mobile**	**Fixed**	**Mobile**	**Fixed**	**Mobile**	**Fixed**
Satellite HO	Not critical	-	Not critical	Not critical	Critical	Critical	Very critical	Critical
Spot HO	Not critical	-	Not critical	-	Critical	Critical	Very critical	Very critical
Gateway HO	Not critical	-	-	-	Not critical	Not critical	Critical	-

Low altitudes and/or high number of spots:
- increased probability of spot handover
- reduced available time to end the procedure

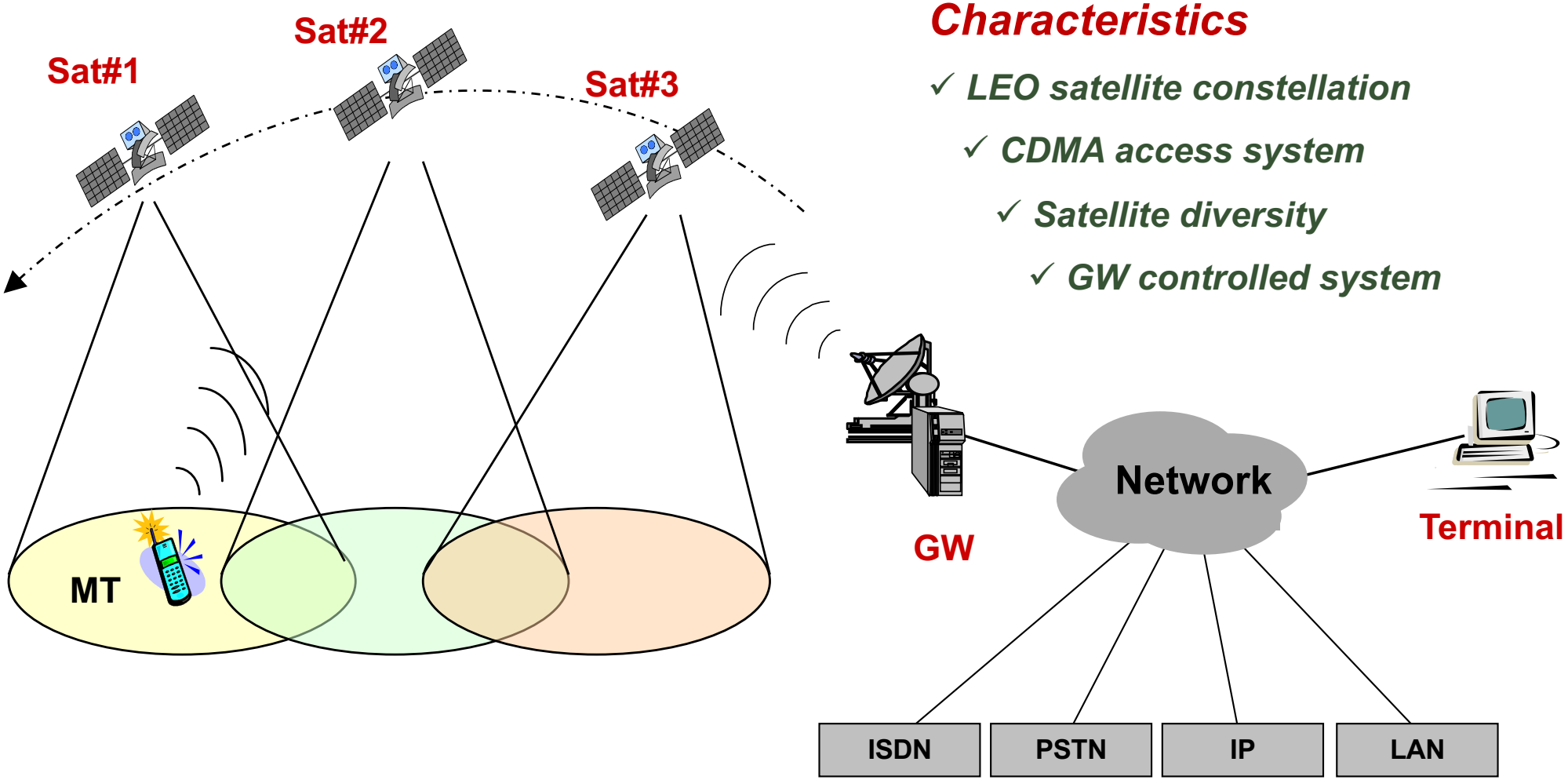
Handover and types of local area coverage

Moving and multiple spots ⇒ All types of handover

Fixed or single spot ⇒ No spot handover

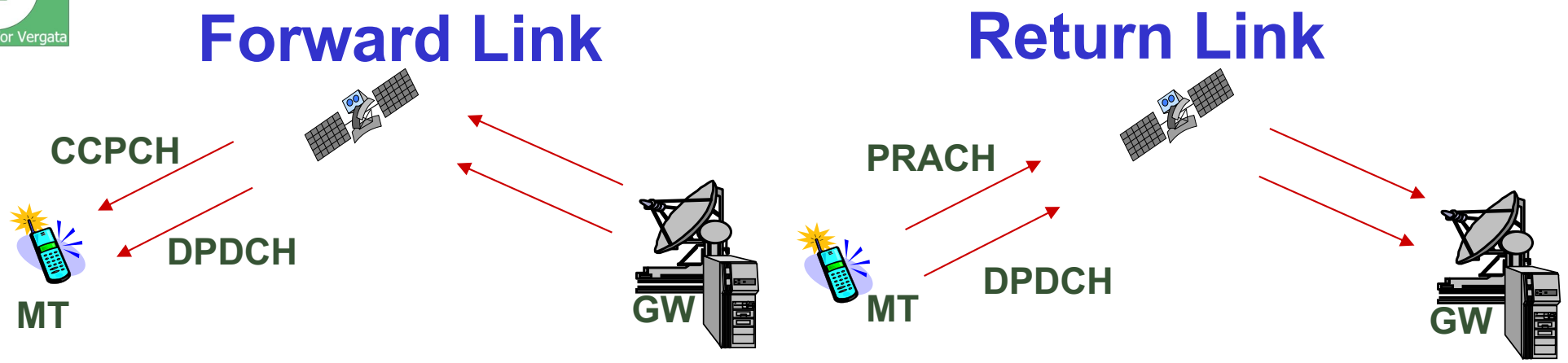
Call Control and Handoff Control procedures for CDMA satellite access link

Scenario



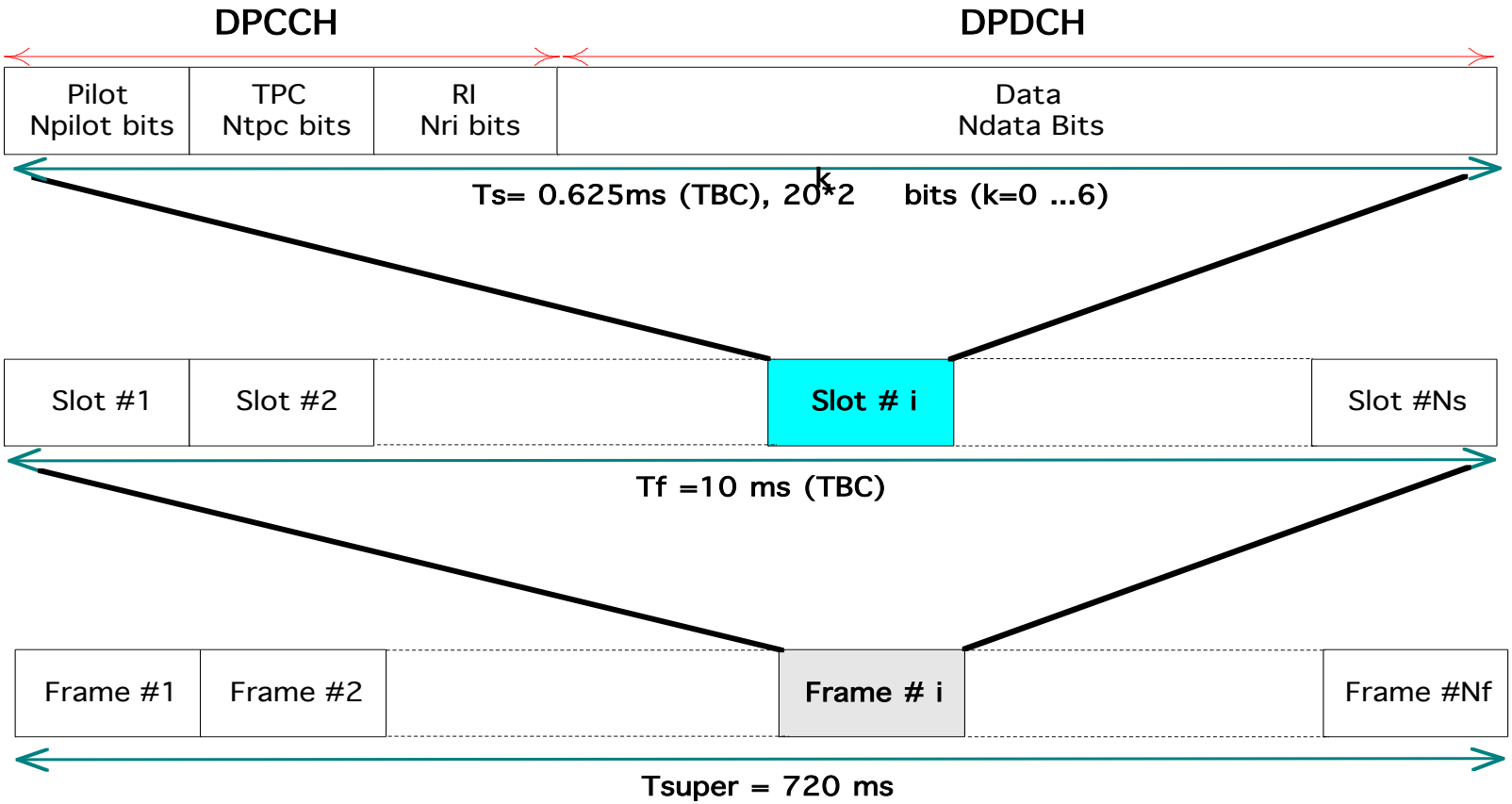
Characteristics

- ✓ *LEO satellite constellation*
- ✓ *CDMA access system*
- ✓ *Satellite diversity*
- ✓ *GW controlled system*



Physical channels		Forward Link	Return Link	
DPDCH (Dedicated Physical Data Channel)	carries the logical channel	DTCH (Dedicated traffic Channel)		supports user traffic
		DCCH (Dedicated Control Channel)		supports in band signalling for control procedures
CCPCH (Common Control Physical Channel)		FACH (Forward Access Channel)		supports out of band signalling for control procedures
PRACH (Physical Random Access Channel)			RACH (Random Access Channel)	

Logical channels over dedicated physical channel



DPDCH = Dedicated Phisical Data Channel = DCCH + DTCH
DCCH = Dedicated Control Channel
DTCH = Dedicated Traffic Channel

Call Control Procedures

- Include all the functionality to set up, maintain and tear down the dedicated physical channel necessary to transfer both user traffic and in band signalling (Dedicated Physical Data Channel)
  - **Registration**
  - **Call Setup**
  - **Handoff Control**
  - **Call Teardown**

Registration

- Involves MT and GW; initiated by MT
- Allows GW to know of the presence of MT in its coverage area
- Such info is used by GW for paging function in case of Call Setup initiated by remote users (or by GW)
- Localization imposed by:
  - Terminal mobility
  - Satellite mobility (LEO, MEO)
- Control messages are exchanged using RACH and FACH channels for out of band signalling (dedicated channel DCCH is not available)

Call Setup

- Both on MT and GW side
- It can be initiated by both MT and GW
- Allows, on demand, to set up a DTCH for user traffic between MT and terrestrial network and viceversa
- If initiated by GW, it is based on paging function
- The channels utilized to exchange control messages are:
  - RACH and FACH for out of band signalling,
  - DCCH, when DPDCH is available
- Call Setup procedure ends when DPDCH is succesfully set up or not

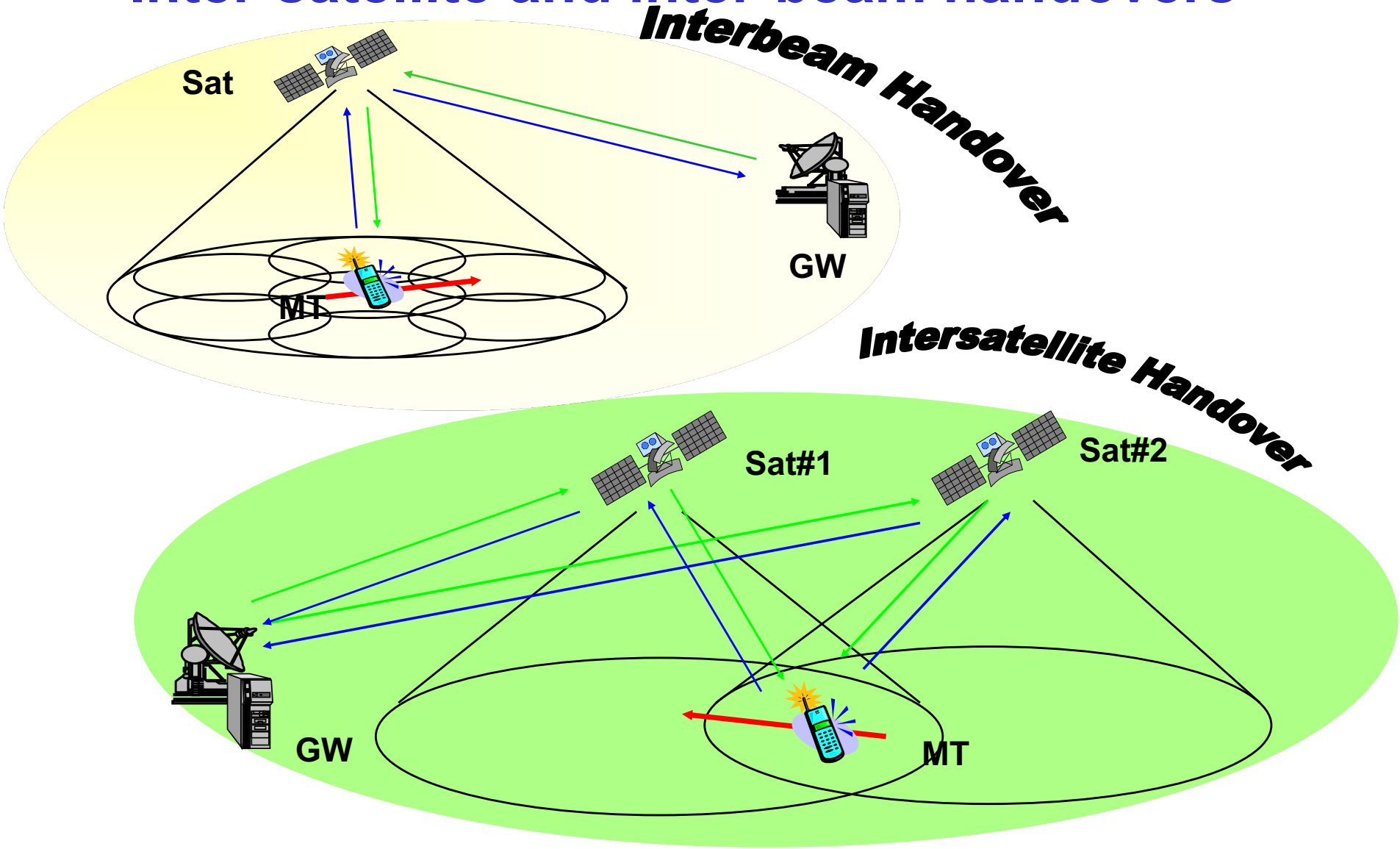
Handover

- Involves both MT and GW
- Initiated by GW on the basis of measurements performed by MT (MAHO) (design option)
- Due to
  - Terminal mobility
  - Satellite mobility (LEO)
- Diversity is supported
- Soft handover
- Control messages are exchanged through DCCH
- Handover procedure ends on demand (Teardown) or in case of loss of coverage

Teardown

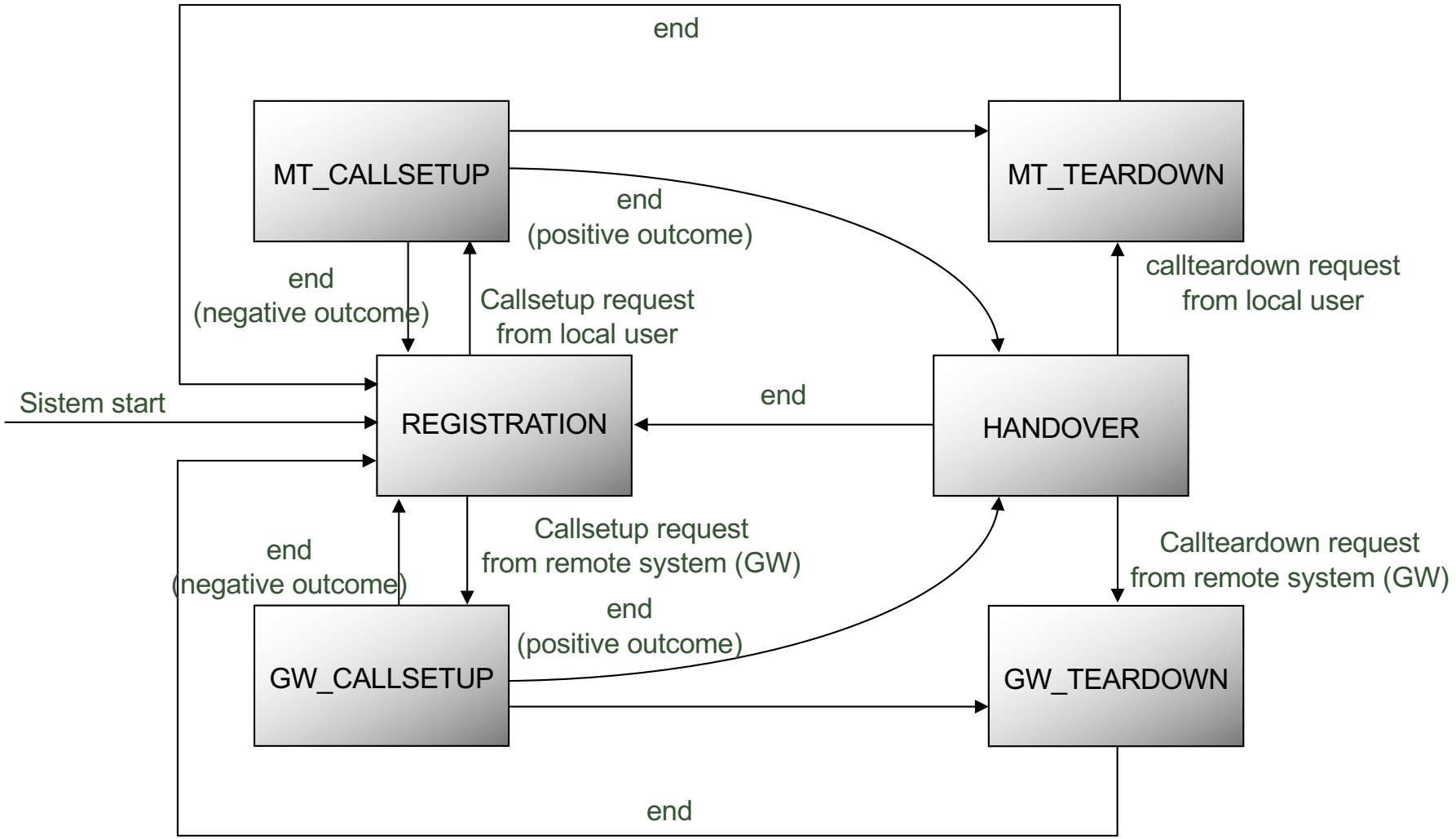
- Both on MT and on GW side, can be initiated both by MT and by GW
- Can be initiated both explicitly by the terminal and by HO procedure
- DPDCH is released
- Control messages are exchanged through DCCH
- Ends always successfully

Inter-satellite and inter-beam handovers

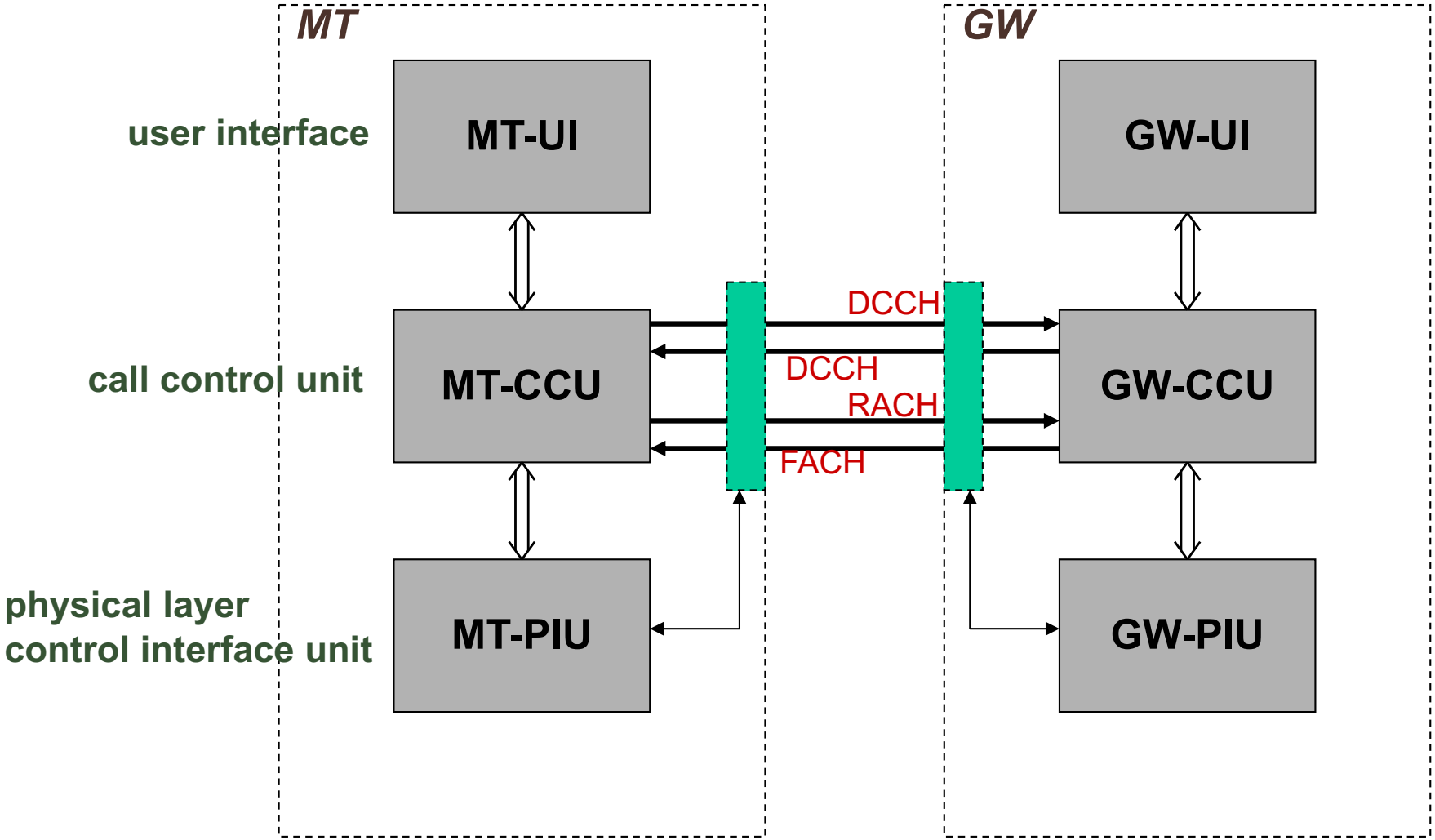


State transition diagram (MT)

Mobile Terminal

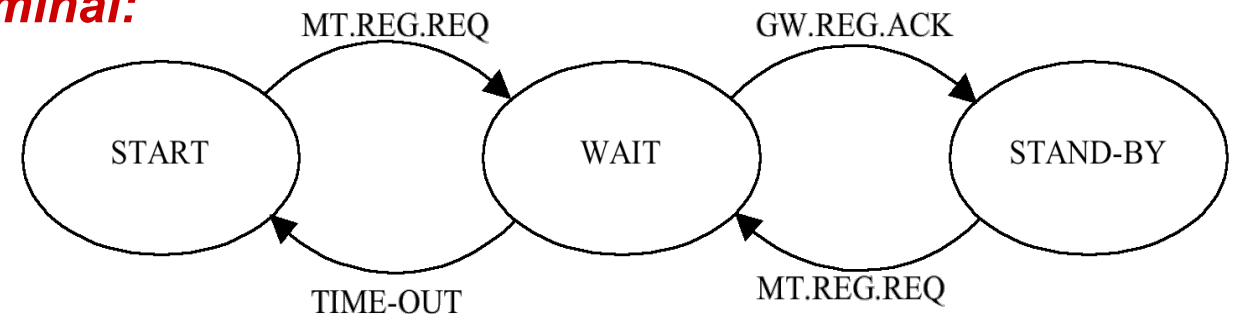


Interfaces - control plane

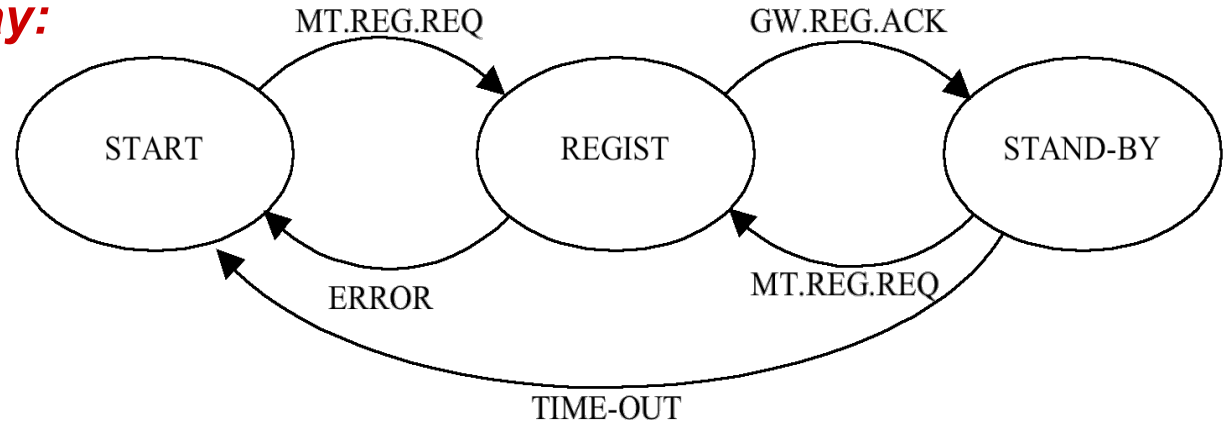


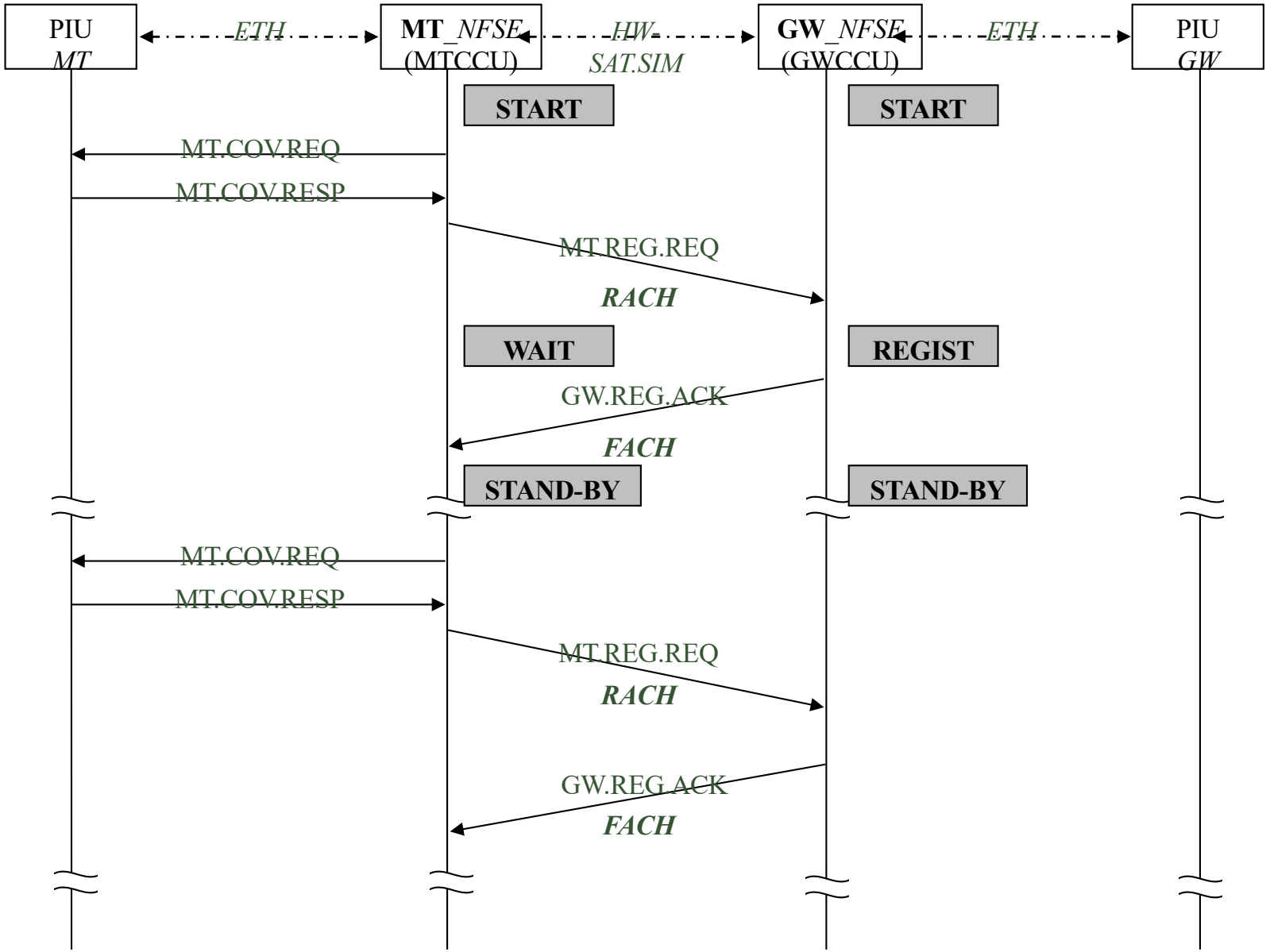
Registration

Mobile Terminal:



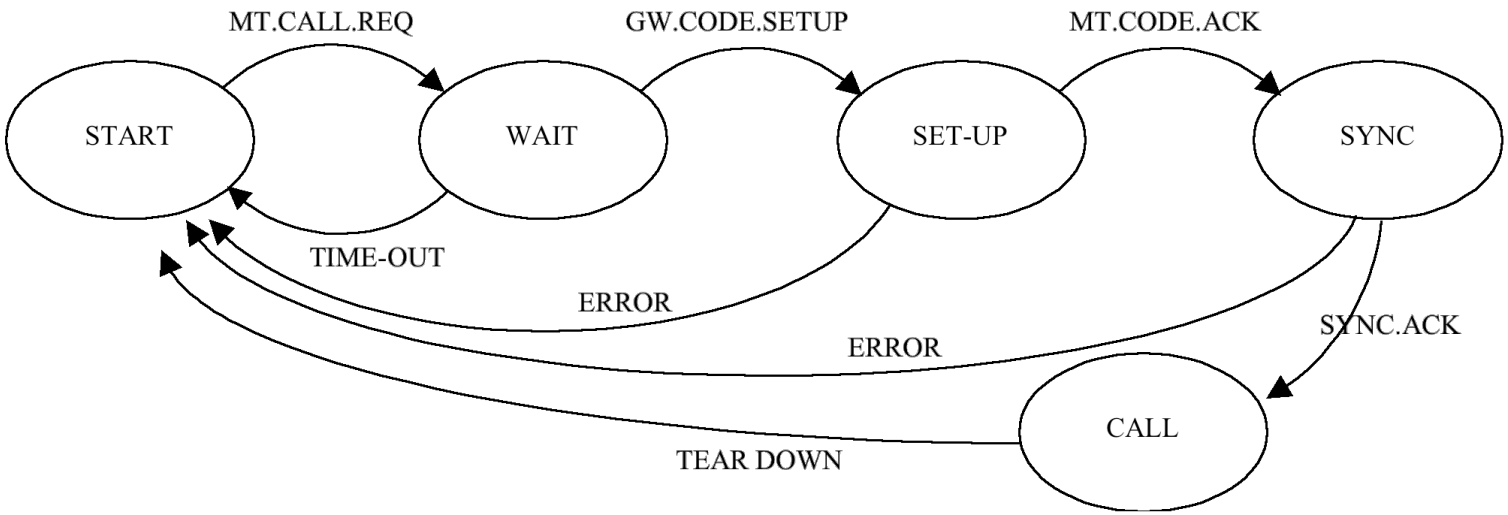
Gateway:



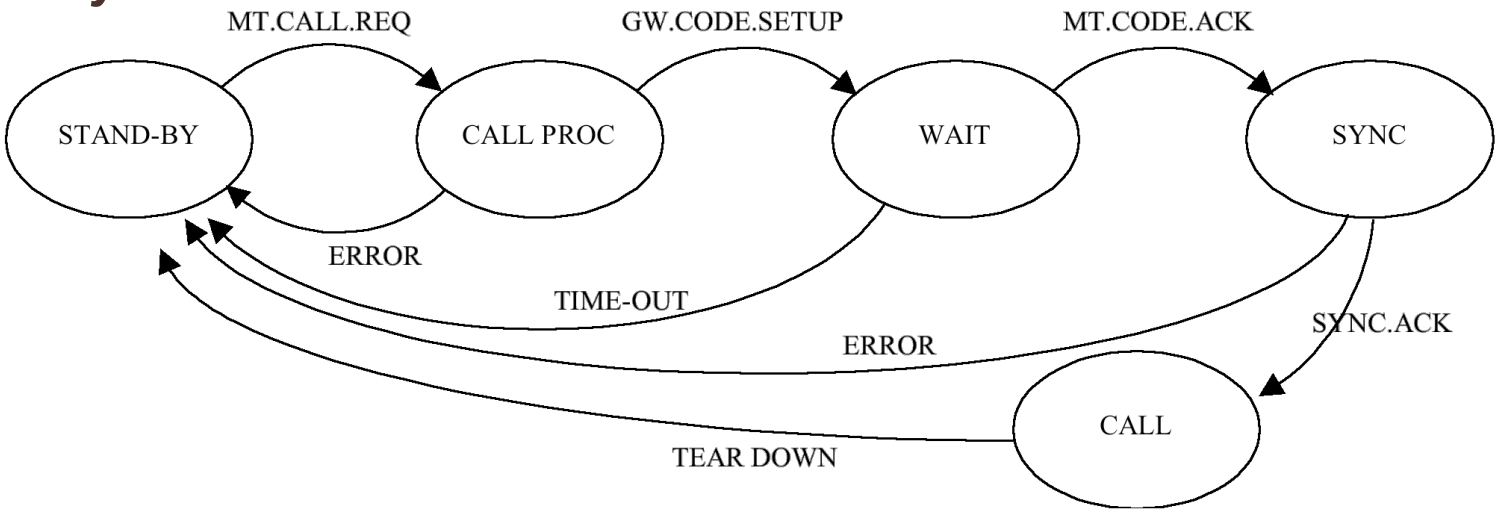

PIU
MT
ETH
MT_NFSE
(MTCCU)
HW-
SAT.SIM
GW_NFSE
(GWCCU)
ETH
PIU
GW
START
START
MT.COV.REQ
MT.COV.RESP
MT.REG.REQ
RACH
WAIT
REGIST
GW.REG.ACK
FACH
STAND-BY
STAND-BY
MT.COV.REQ
MT.COV.RESP
MT.REG.REQ
RACH
GW.REG.ACK
FACH

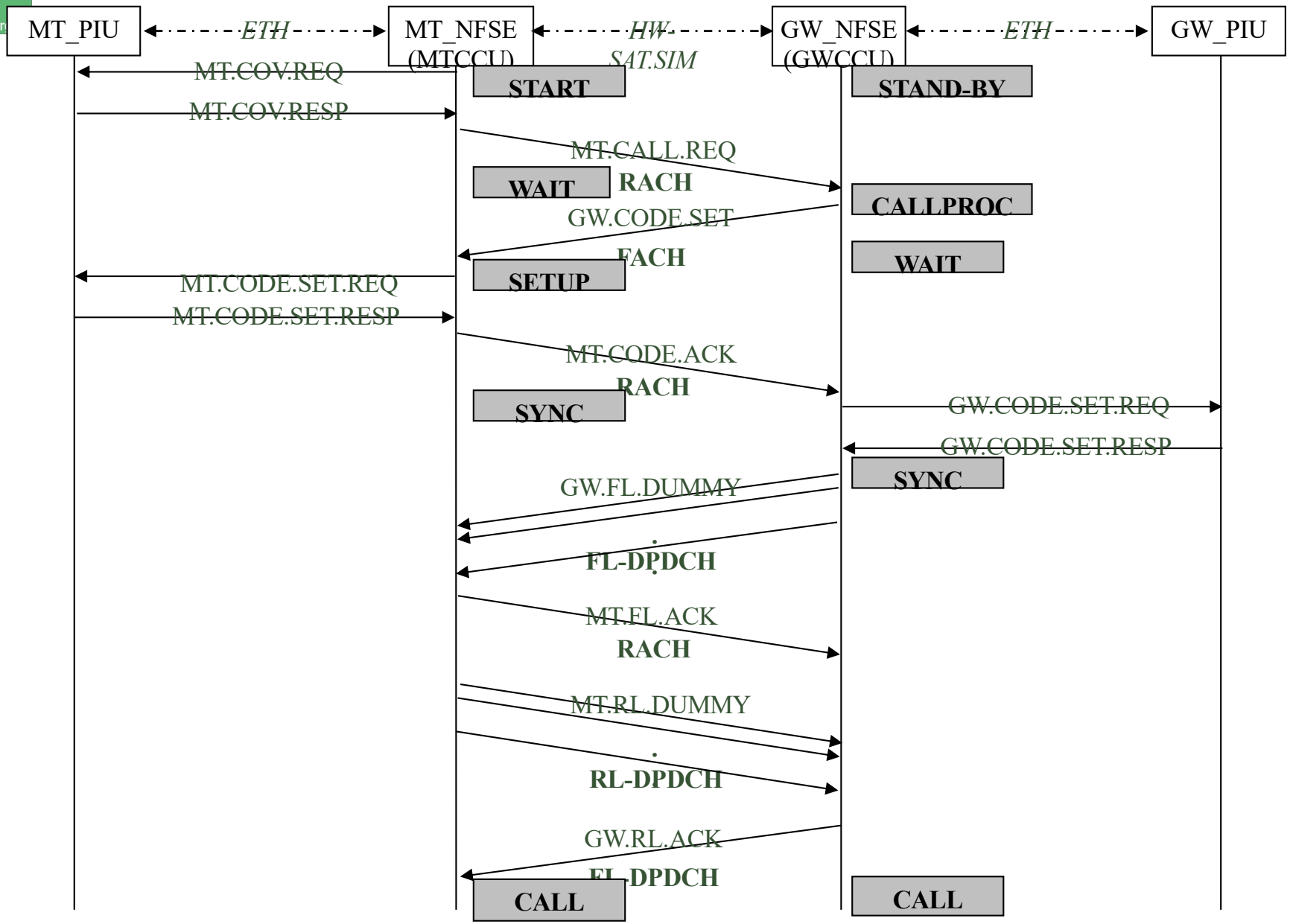
Call Setup initiated by MT

Mobile Terminal:



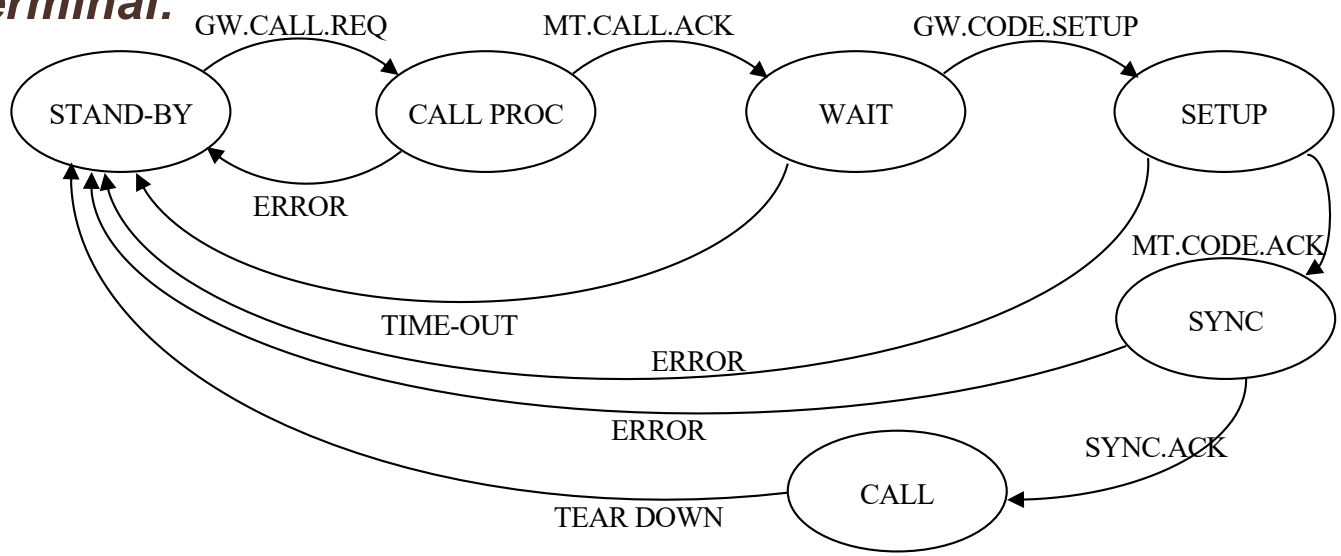
Gateway:



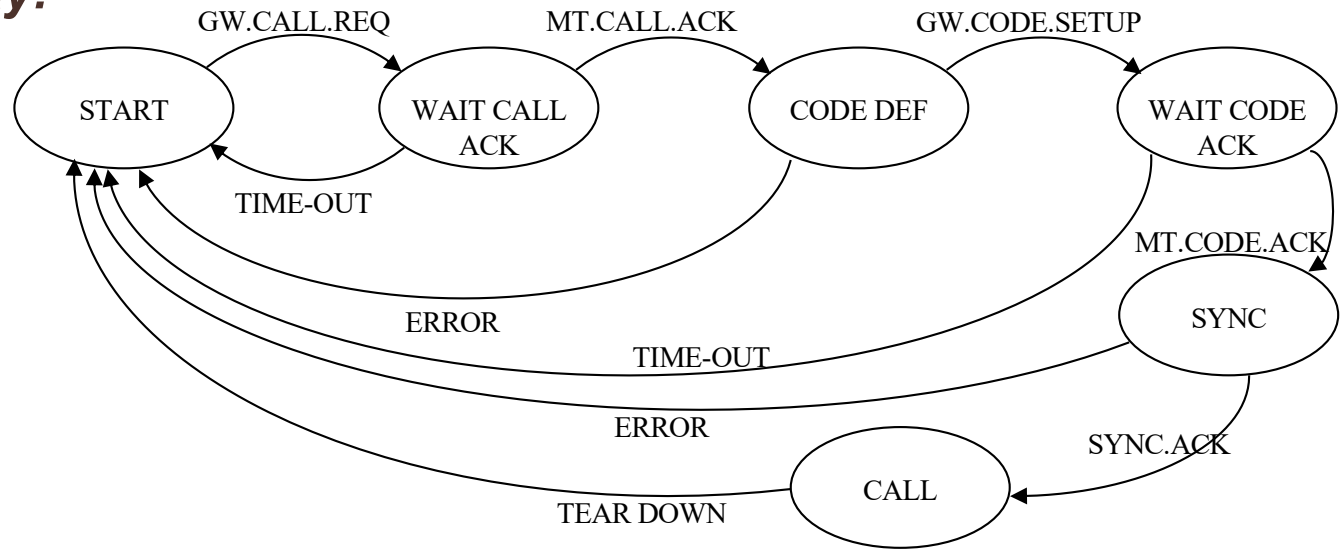

MT_PIU
ETH
MT_NFSE (MTCCU)
HW SAT.SIM
GW_NFSE (GWCCU)
ETH
GW_PIU
MT.COV.REQ
START
STAND-BY
MT.COV.RESP
MT.CALL.REQ
WAIT
RACH
CALLPROC
GW.CODE.SET
FACH
WAIT
SETUP
MT.CODE.SET.REQ
MT.CODE.SET.RESP
MT.CODE.ACK
RACH
SYNC
GW.CODE.SET.REQ
GW.CODE.SET.RESP
SYNC
GW.FL.DUMMY
FL-DPDCH
MT.FL.ACK
RACH
MT.RL.DUMMY
RL-DPDCH
GW.RL.ACK
FL-DPDCH
CALL
CALL

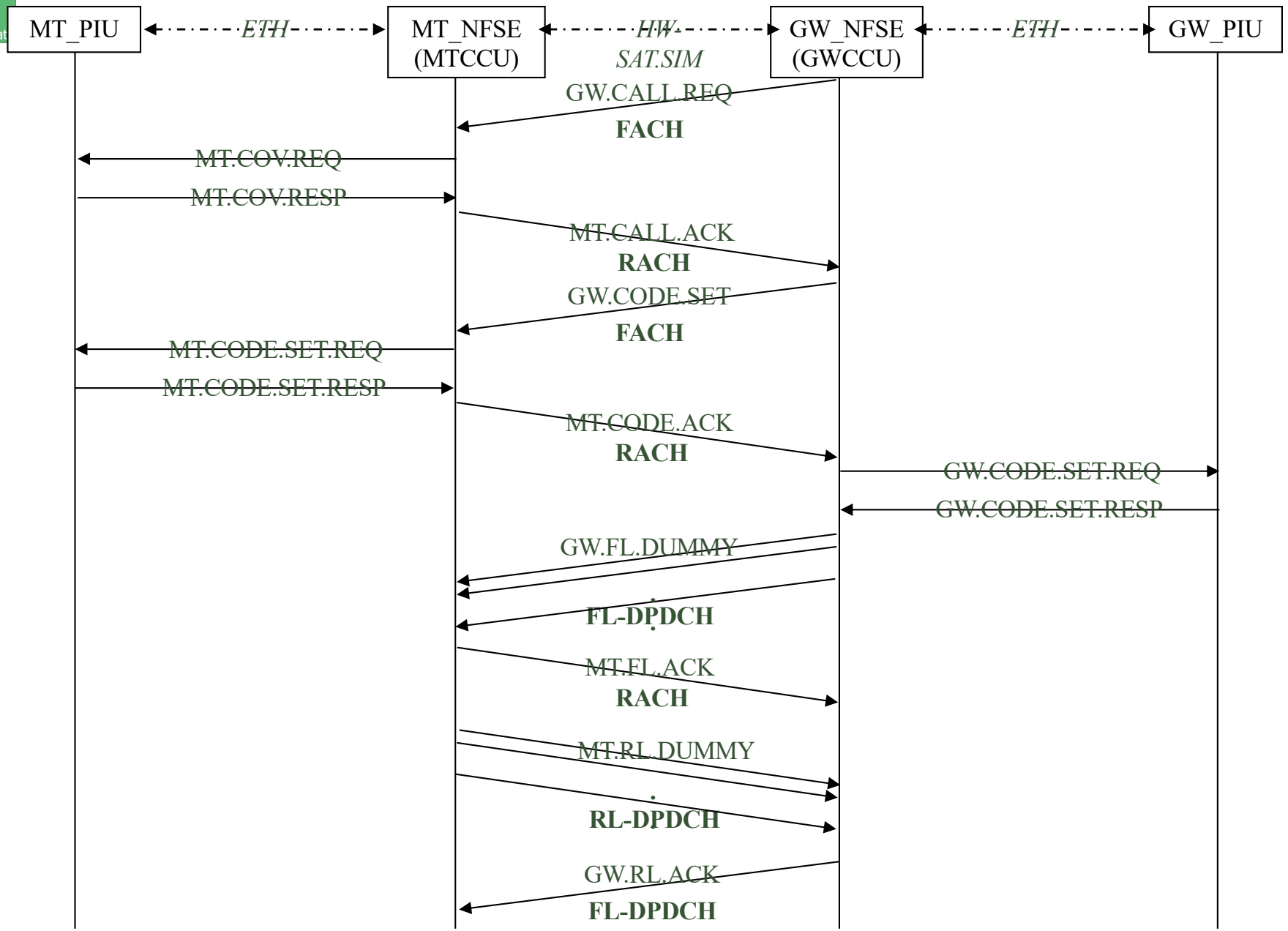
Call Setup initiated by GW

Mobile Terminal:



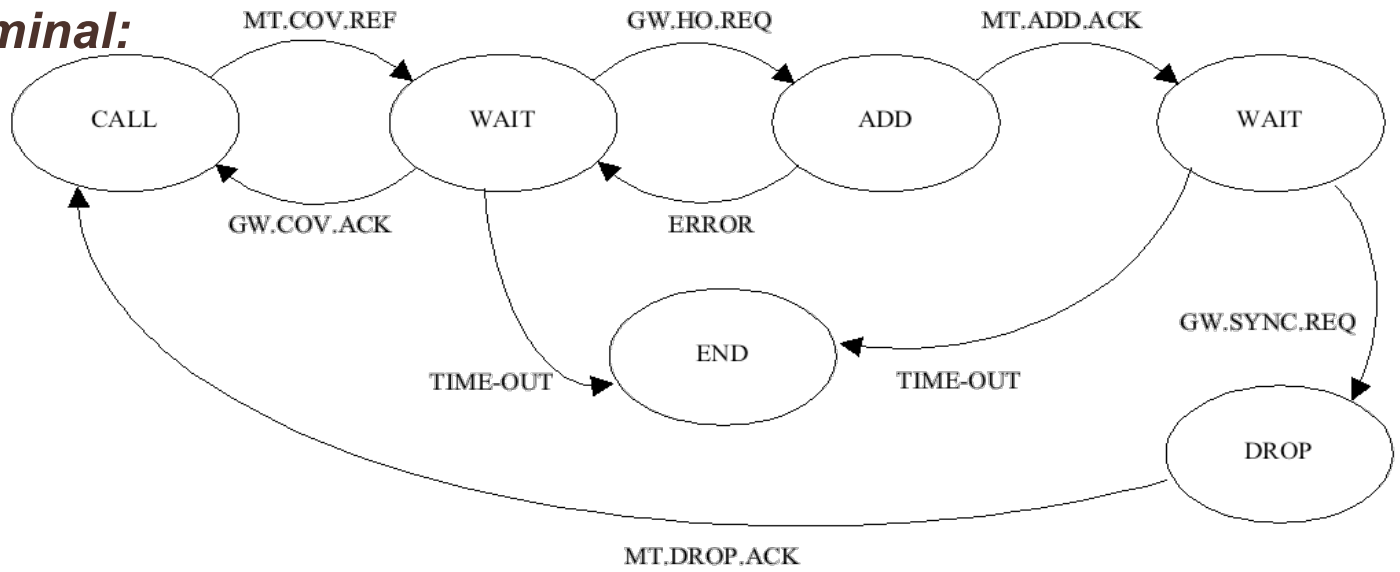
Gateway:



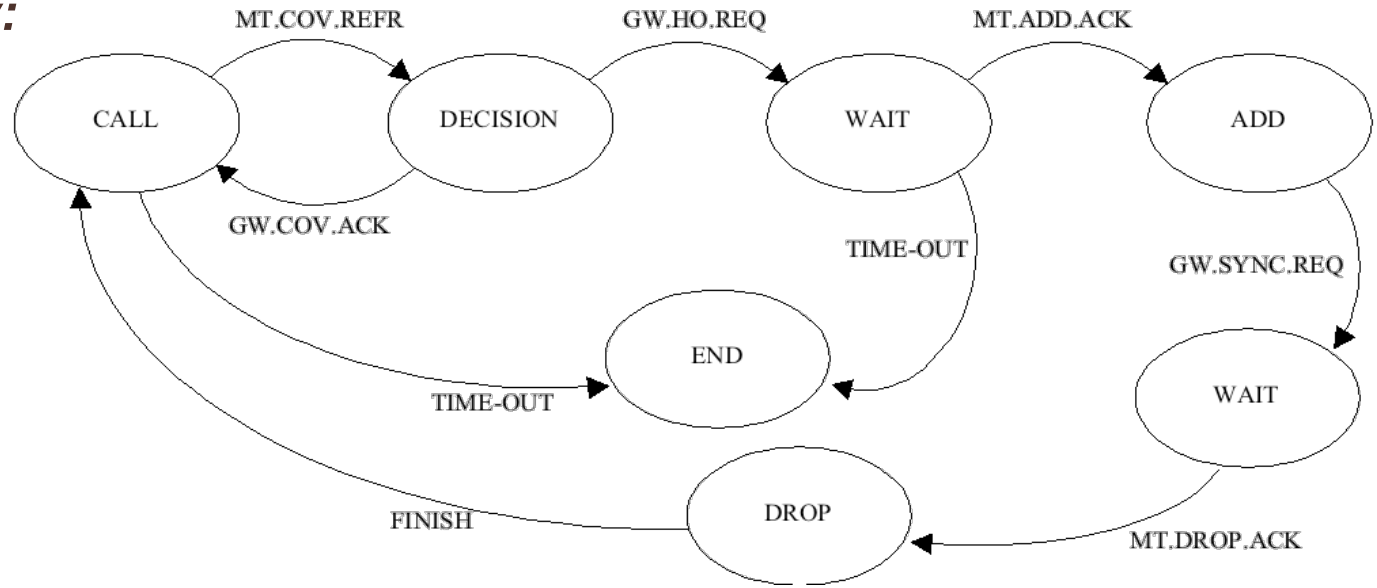

MT_PIU
ETH
MT_NFSE (MTCCU)
HW SAT.SIM
GW_NFSE (GWCCU)
ETH
GW_PIU
GW.CALL.REQ
FACH
MT.COV.REQ
MT.COV.RESP
MT.CALL.ACK
RACH
GW.CODE.SET
FACH
MT.CODE.SET.REQ
MT.CODE.SET.RESP
MT.CODE.ACK
RACH
GW.CODE.SET.REQ
GW.CODE.SET.RESP
GW.FL.DUMMY
FL-DPDCH
MT.FL.ACK
RACH
MT.RL.DUMMY
RL-DPDCH
GW.RL.ACK
FL-DPDCH

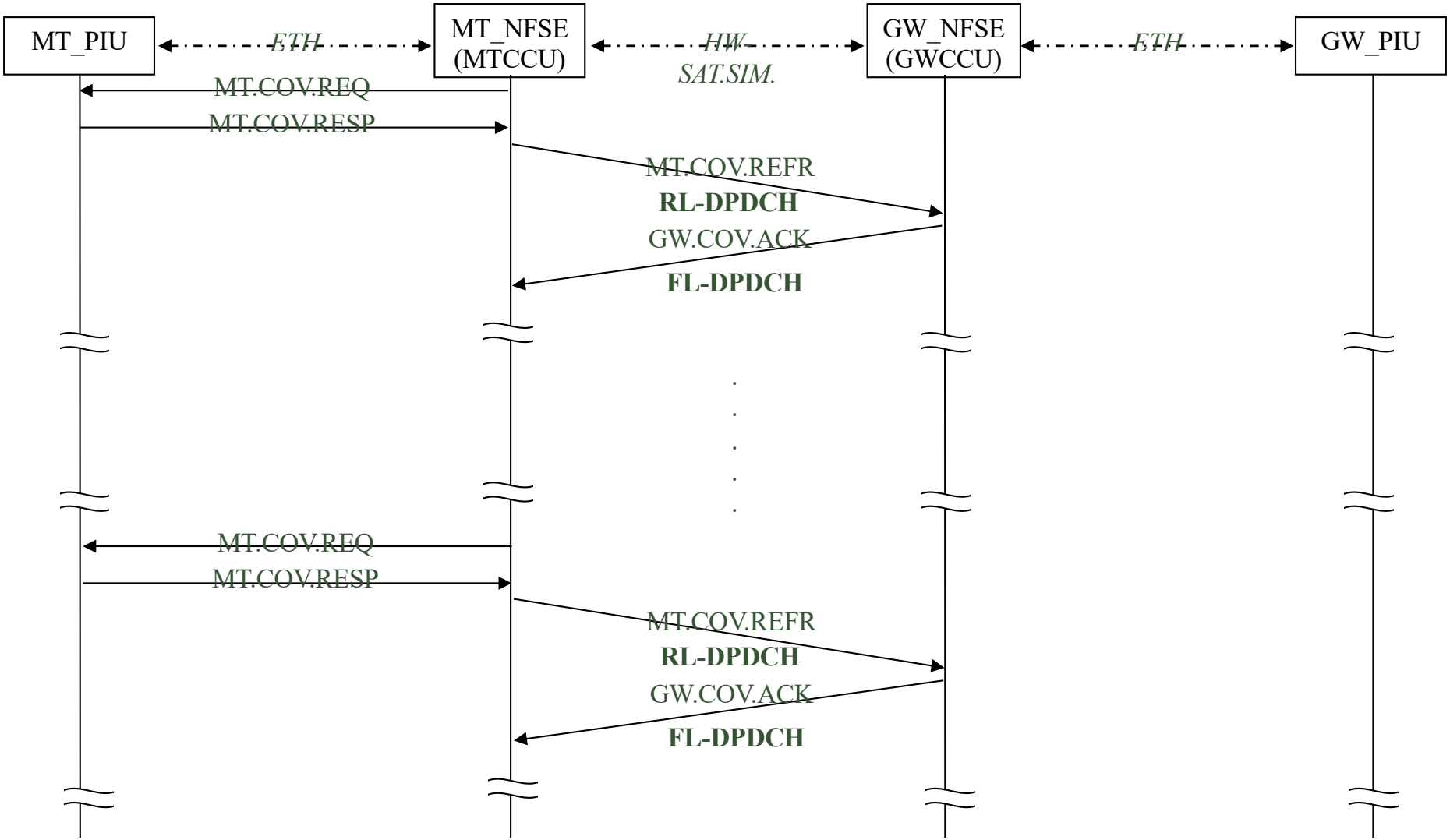
Handover

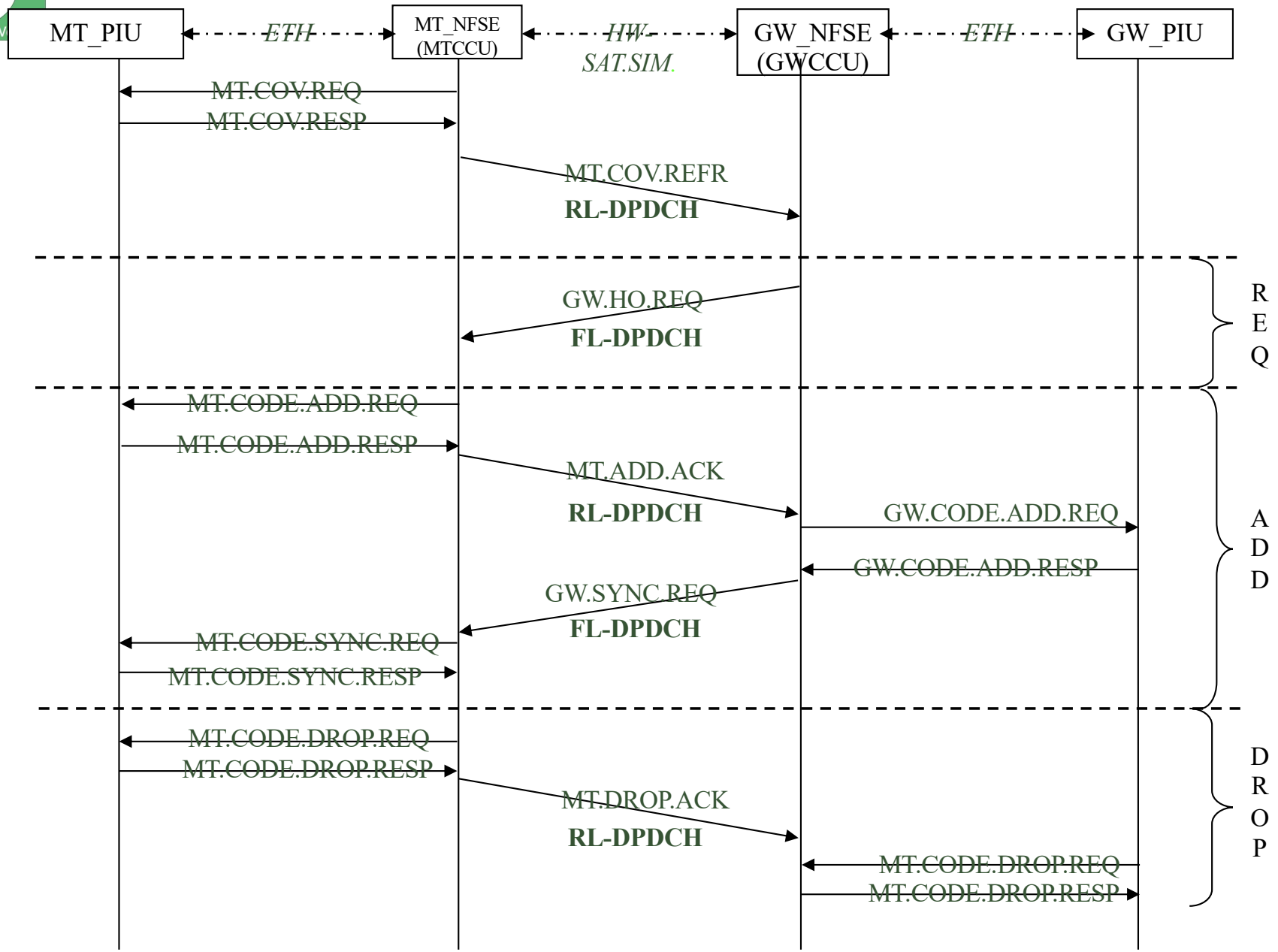
Mobile Terminal:



Gateway:




MT_PIU
ETH
MT_NFSE (MTCCU)
HW – SAT.SIM.
GW_NFSE (GWCCU)
ETH
GW_PIU
MT.COV.REQ
MT.COV.RESP
MT.COV.REFR
RL-DPDCH
GW.COV.ACK
FL-DPDCH
MT.COV.REQ
MT.COV.RESP
MT.COV.REFR
RL-DPDCH
GW.COV.ACK
FL-DPDCH


MT_PIU
ETH
MT_NFSE (MTCCU)
HW-SAT.SIM.
GW_NFSE (GWCCU)
ETH
GW_PIU
MT.COV.REQ
MT.COV.RESP
MT.COV.REFR
RL-DPDCH
GW.HO.REQ
FL-DPDCH
REQ
MT.CODE.ADD.REQ
MT.CODE.ADD.RESP
MT.ADD.ACK
RL-DPDCH
GW.CODE.ADD.REQ
GW.CODE.ADD.RESP
GW.SYNC.REQ
FL-DPDCH
MT.CODE.SYNC.REQ
MT.CODE.SYNC.RESP
ADD
MT.CODE.DROP.REQ
MT.CODE.DROP.RESP
MT.DROP.ACK
RL-DPDCH
MT.CODE.DROP.REQ
MT.CODE.DROP.RESP
DROP