Developing Gridded Product for Enterprise Land Algorithms

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Outline

- Introduction
  - Team Members/Users
- Background
  - Algorithms Products
  - Challenges
- Enterprise Algorithm Development
  - Current Operational Product:
  - Enterprise Algorithm approach
  - Development Strategy
  - Design/ High level process flow
  - Testing and Validation: what we have and going to do
  - Schedules and Milestones
- Risks
- Summary and Recommendations

Team Members /Users

Name	Organization	Major Task
Ivan Csiszar	NOAA/NESDIS/STAR	Land Lead, Project Management
Marina Tsidulko	IMSG@NOAA/NESDIS/STAR	Algorithm Design/Development
Jerry Zhan	NOAA/NESDIS/STAR	Surface Type Lead
Bob Yu	NOAA/NESDIS/STAR	LST, LSA Lead
Marco Vargas	NOAA/NESDIS/STAR	VI Based Products Lead
Peter Romanov	UMD@NOAA/NESDIS/STAR	Snow Products Lead
Felix Kogan	NOAA/NESDIS/STAR	VHP Lead
Walter Wolf	NOAA/NESDIS/STAR	STAR AIT Lead
Michael EK	NOAA/NCEP/EMC	Noah Land Surface Model Lead
Land teams members	STAR, EMC, IMSG, UMD	Algorithm development/testing

Background

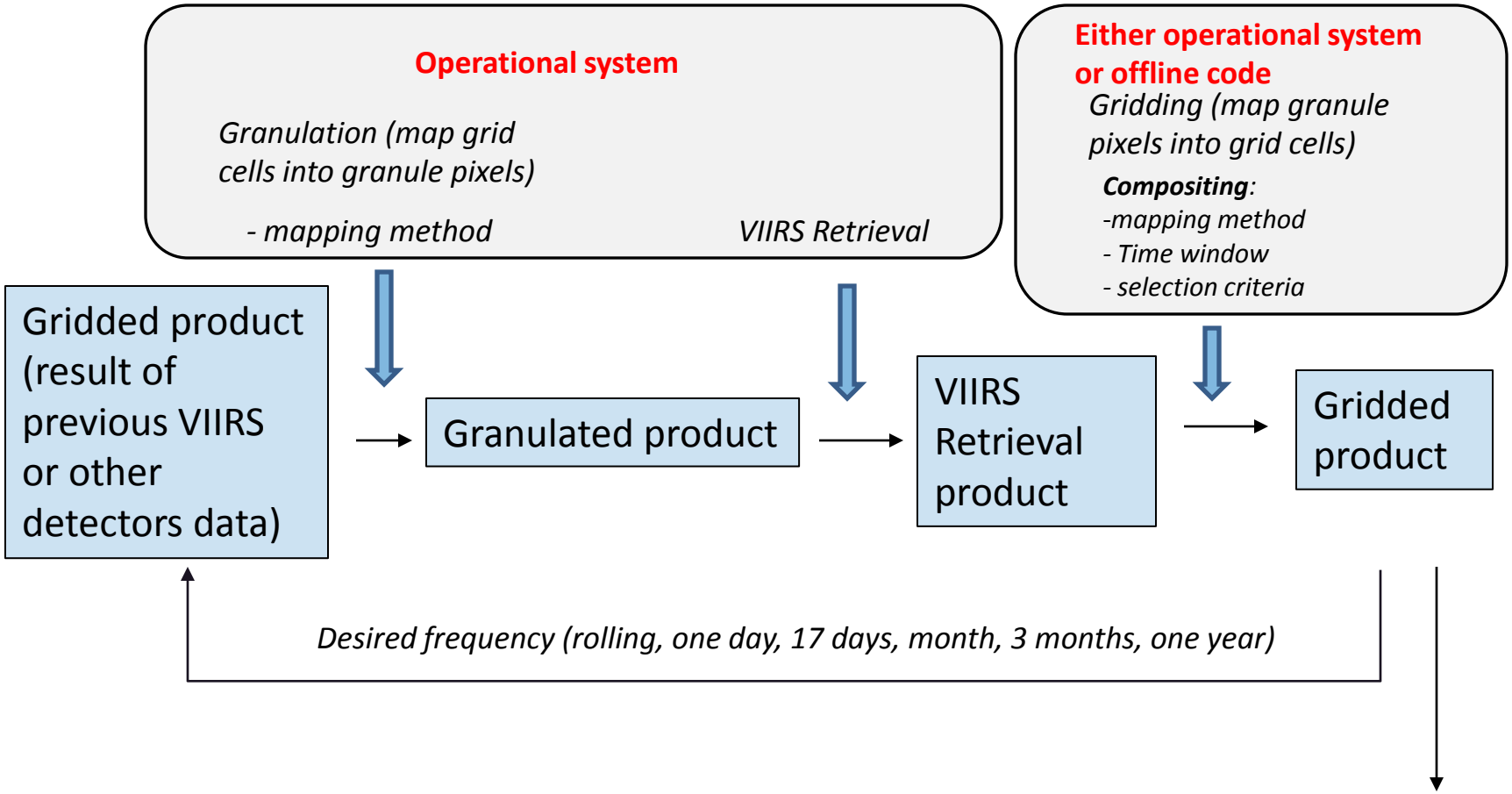
Gridding purposes:

- Within online system/granule level chain run:
  - Gridded products are used as ancillary data inputs for future retrievals (could be combination of different satellite sources)

- Outside granule level chain run:
  - Land products need to be in regular grid for Land/Surface model (e.g. Noah) within NWP models – unlike SDR and other retrieval products which go to data assimilation system being pixel-level.
  - Pixel level land products usually serve as inputs for downstream products and less frequently are required as final product (e.g. AF)

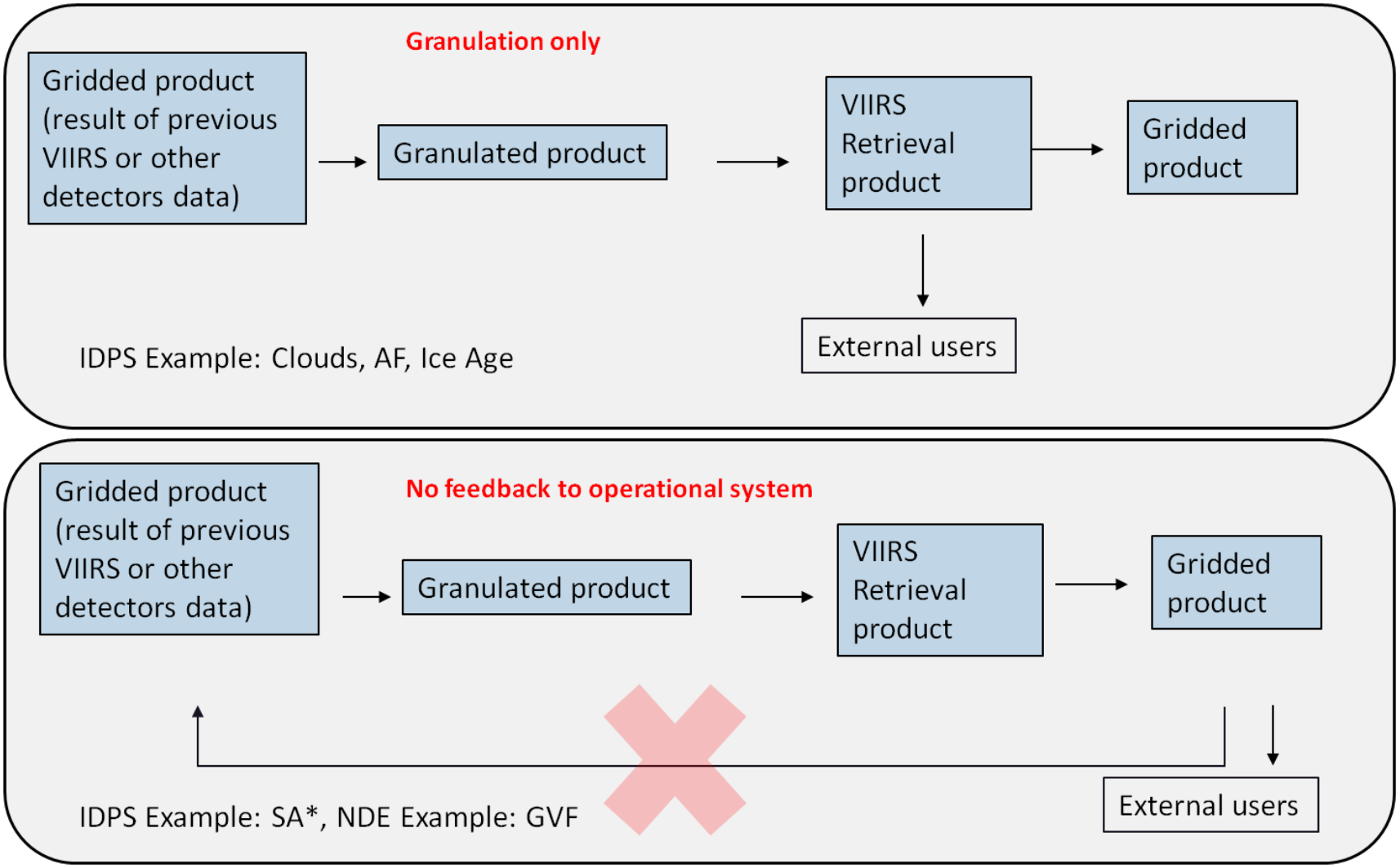
Background

VIIRS Gridding/Granulation concept



Full Gridding/Granulation cycle

Background


Granulation only
Gridded product (result of previous VIIRS or other detectors data)
Granulated product
VIIRS Retrieval product
Gridded product
External users
IDPS Example: Clouds, AF, Ice Age
No feedback to operational system
Gridded product (result of previous VIIRS or other detectors data)
Granulated product
VIIRS Retrieval product
Gridded product
External users
IDPS Example: SA*, NDE Example: GVF

Operational IDPS Concept

IDPS gridding/granulation: definitions

Term	Description
Granulation	Copying/Converting data from a grid to a granule. This is GridToGran.
Gridding	Updating a Gridded IP with data (either Granule data or other GIP data). This could be GranToGrid or GridToGrid processing.
Collecting	Collecting is simply inserting new data values into the GIP without affecting the current values. In some cases, the number of data values in the collection is capped to limit resource usage. An example is the Daily Surface Reflectance GIP, which collects a certain number of observations per grid cell depending on the latitude zone of the tile (Max of 2 at Equator and 15 at Poles). Once the maximum number of observations has been collected, any additional observations during that period are discarded.
Compositing	Combining gridded data through data selection, weighting, interpolation, and/or averaging to create a single value per global grid cell that is representative of the retrieval at that location during a specific time period. An example is CV-MVC, which is used during GranToGrid on the Monthly SR/BT/VI GIP. Another example is Best Choice, which continually chooses the best value for the grid cell between current and newly-received.
Rolling Update GIP	GIP that is continuously updated with NPOESS Data Product granules. There is no specific period for a Rolling Update GIP – it is maintained forever.

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Operational IDPS Concept

IDPS gridding/granulation: mapping methods

1. Nearest Neighbor (NN)
   - simplest method
2. Area Weight (AW)
   - most complicated
   - takes into account particular pixel shape and temporal scale (areas of the pixel that have less time visible to detector get less weight)
   - heritage of MODIS gridding with considerations for VIIRS aggregation zones
3. Greatest Weight Neighbor (GWN)

The VIIRS Gridding/Granulation software uses three different methods of Pixel-To-Cell mapping: **1.) Nearest Neighbor (NN), 2.) Area Weight (AW), and 3.) Greatest Weight Neighbor (GWN)** in deciding which method should be applied for a particular GIP algorithm, the trade-off of accuracy vs. latency has to be considered. For example, NN is very fast in terms of execution, while GWN is much slower than NN, and AW is even slower than GWN. However, AW is expected to be the most accurate, with GWN being less accurate than AW, and NN being the least accurate. **NN** is a method of Pixel-To-Cell mapping whereby the **single closest (nearest) match** is selected. The **AW** Pixel-To-Cell mapping identifies the **set of all matches that intersect the defined region** (pixel or grid cell). **GWN selects the single greatest weighted match (according to the AW calculation).**

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Operational IDPS Concept

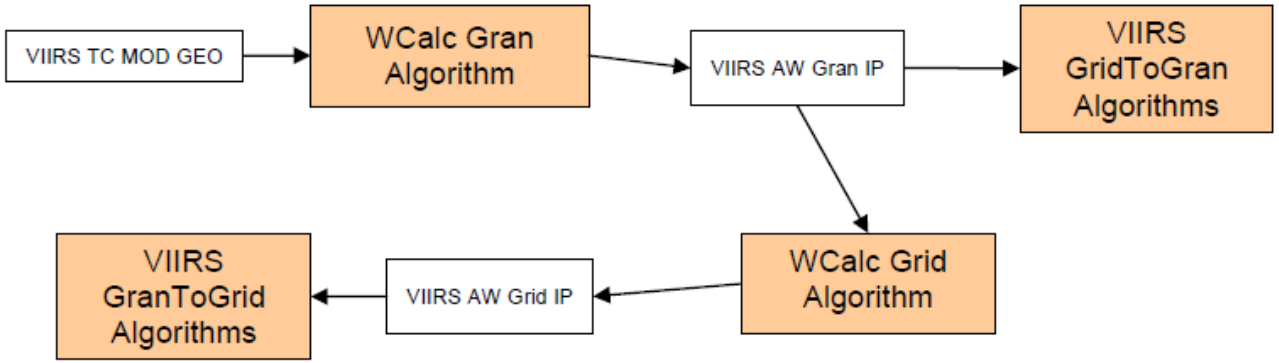

Figure 6. WCalc Interrelationships Diagram

The VIIRS Area Weight Calculator (WCalc) produces two products. The first product is the Gran product. For each pixel in the granule, it contains **a list of grid cells** (up to a maximum) **which contribute to the pixel**. This list contains the grid cell's row, column, tile ID, and **weight (percentage of the grid cell that the pixel covers)**. The second product is the Grid product. This product covers the same area of the earth, but is structured in such a way that it is a list of contributing pixels rather than a two-dimensional array of grid cells. For each of these grid cells, it contains **a list of pixels** (up to a maximum) **which contribute to the cell**. This list contains the pixel's row, column, and weight (percentage of the pixel that the grid cell covers).

Operational IDPS Concept

IDPS gridding/granulation: processing chain

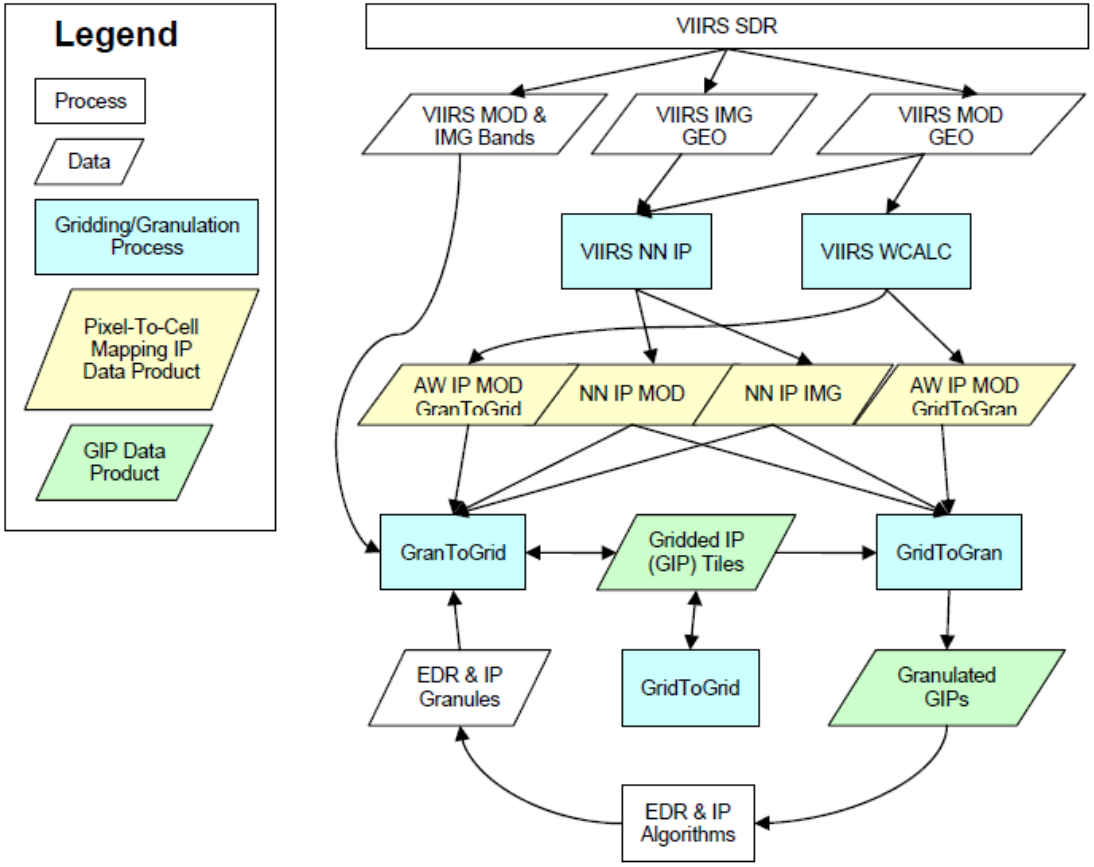

Figure 1. General Processing Chain Interrelationships Diagram

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Operational IDPS Concept

IDPS gridding/granulation: summary

Table 3. GIP Algorithm Summary

GIP	GridToGran	GranToGrid	GridToGrid
Snow Ice Cover	GWN	NN	n/a
Quarterly Surface Type	GWN	n/a	Delivered to IDPS, Once every 3 months[11]
Ann Max/Min NDVI	GWN	n/a	Delivered to IDPS, Once every 3 months[12]
~~Land Surface Albedo~~	~~AW[13]~~	~~n/a~~	~~Once every 17 days~~
QST-LWM	GWN	n/a	Delivered to IDPS, Once every 3 months[14]
Daily Surface Reflectance	n/a	AW	n/a
Monthly SR/BT/VI	n/a	AW	Post Composite Data Reduction, Once a month
BRDF Archetypal	n/a	n/a	Once every 17 days
NBAR-NDVI Rolling	GWN	n/a	Once every 17 days
NBAR-NDVI Monthly	n/a	n/a	Once a month[15]
NBAR-NDVI 17 Day	n/a	n/a	Once every 17 days

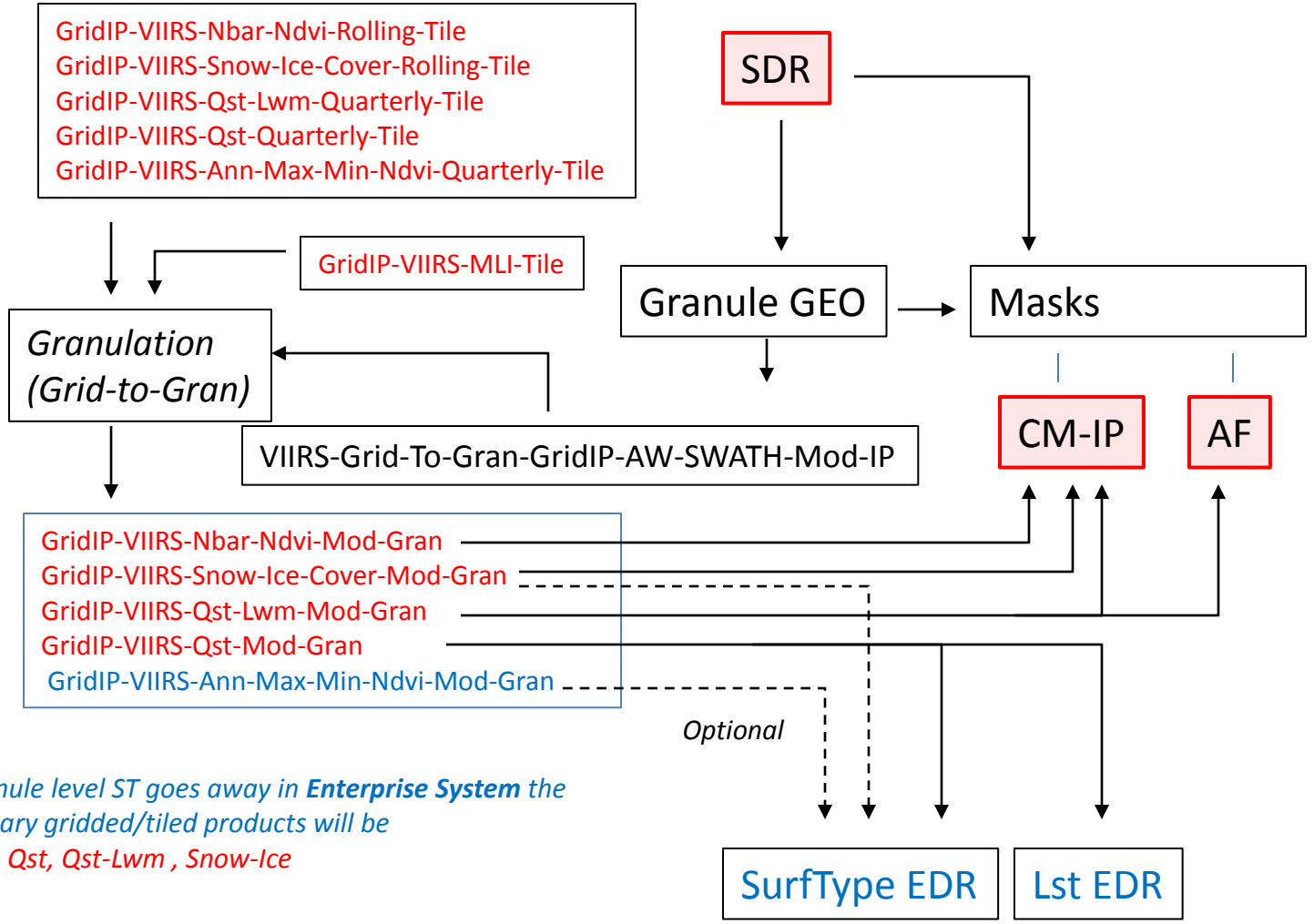
Not relevant anymore

Table 5. GridToGran Consumers

Granulated GIP	Consumer
Snow Ice Cover	VIIRS Cloud Mask IP
Quarterly Surface Type	VIIRS Surface Type EDR VIIRS Land Surface Temperature EDR[20]
Ann Max/Min NDVI	VIIRS Surface Type EDR
~~Land Surface Albedo~~	~~VIIRS Land Surface Albedo IP~~
QST-LWM	VIIRS Cloud Mask IP VIIRS Fire Mask IP
NBAR-NDVI	VIIRS Cloud Mask IP

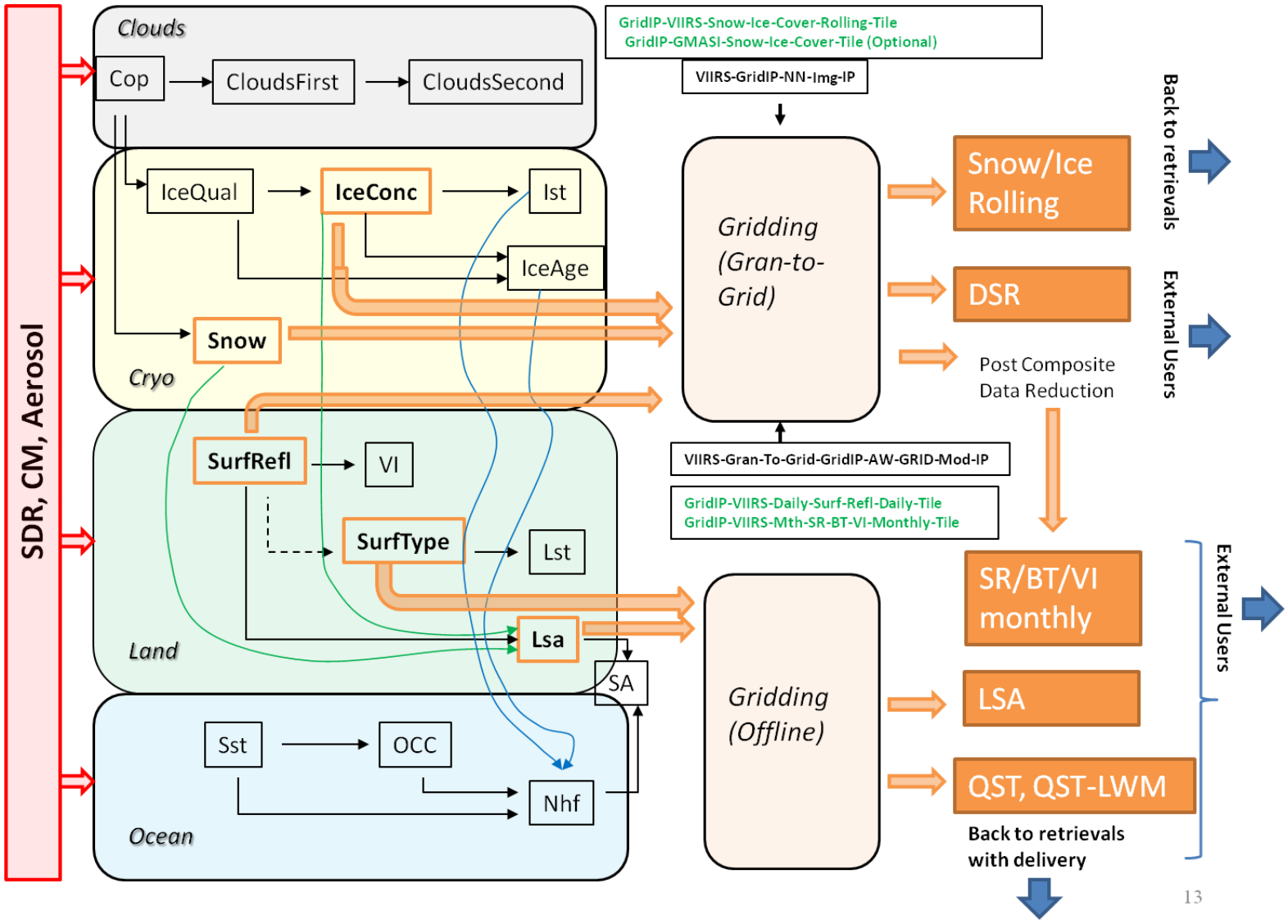
Operational IDPS Concept

IDPS: Gridded products (Tiles) for granulation



*If pixel/granule level ST goes away in **Enterprise System** the only necessary gridded/tiled products will be Nbar-Ndvi, Qst, Qst-Lwm , Snow-Ice*

Operational IDPS Concept



13

Operational IDPS Concept

Tiles gridded in IDPS with grid-to-grid

GridIP-VIIRS-Ann-Max-Min-Ndvi-Quarterly-Tile
GridIP-VIIRS-Brdf-Arch-17Day-Tile
GridIP-VIIRS-Nbar-Ndvi-Monthly
GridIP-VIIRS-Nbar-Ndvi-Rolling-Tile

Gridding
(Grid-to-grid)

Back to retrievals

Current gridded products (tiles) in the IDPS (ADL5.3)

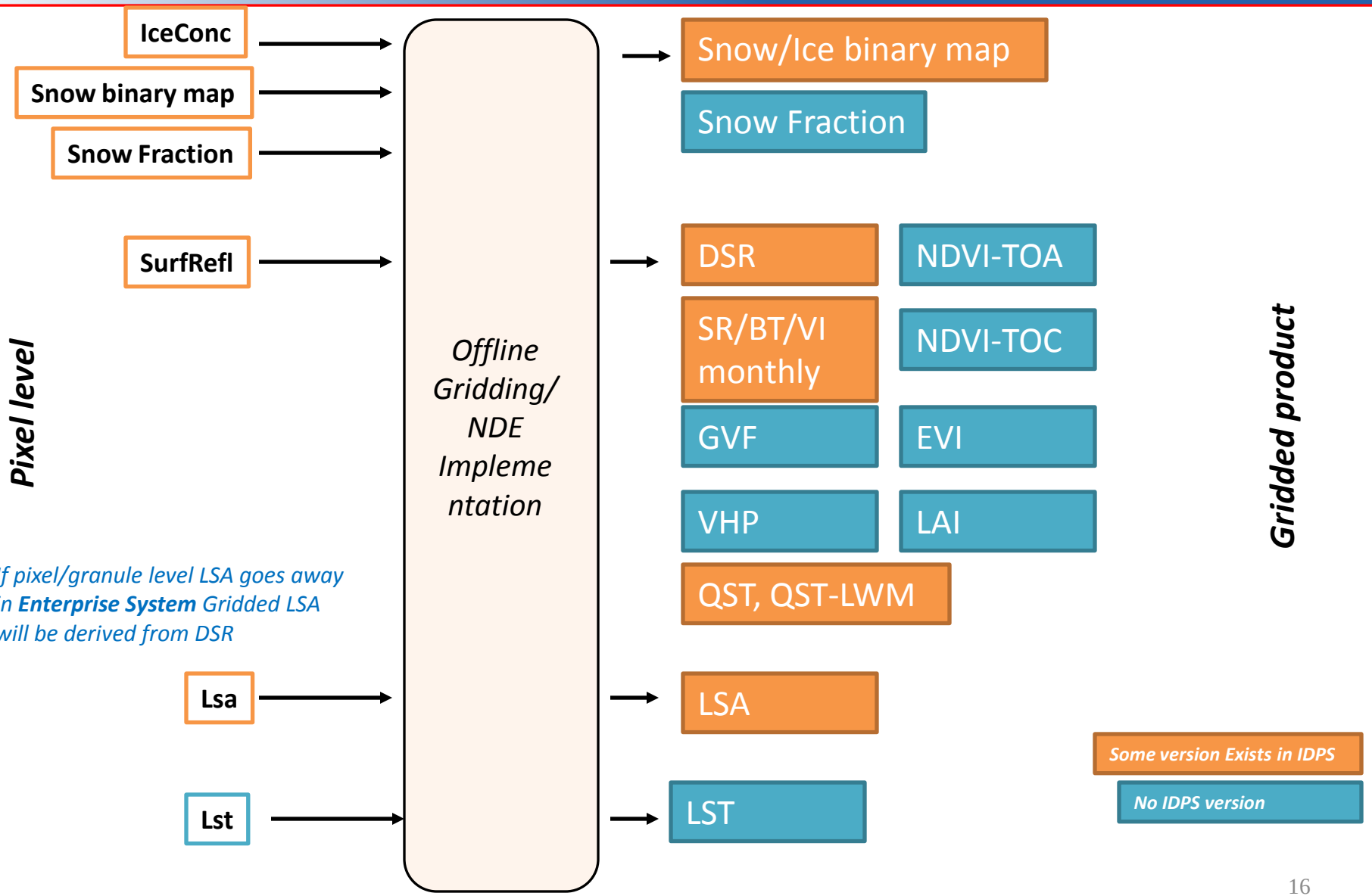
GridIP-VIIRS-Ann-Max-Min-Ndvi-Quarterly-Tile_Nov_2012_CCR1700
GridIP-VIIRS-Brdf-Arch-17Day-Tile_Oct_2012_CCR692
GridIP-VIIRS-Daily-Surf-Refl-Daily-Tile
GridIP-VIIRS-Daily-Surf-Refl-Template-Daily-Tile_Nov_2012_CCR1700
GridIP-VIIRS-Land-Surf-Albedo-17Day-Tile_Nov_2012_CCR1700
GridIP-VIIRS-MLI-Tile_Apr_2014_CCR1700
GridIP-VIIRS-Mth-SR-BT-VI-Monthly-Tile
GridIP-VIIRS-Mth-SR-BT-VI-Template-Monthly-Tile_Nov_2012_CCR1700
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Apr2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Aug2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Dec2011
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Feb2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Jan2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Jul2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Jun2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Mar2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_May2012
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Nov2011
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Oct2011
GridIP-VIIRS-Nbar-Ndvi-Monthly-Tile_Sep2012
GridIP-VIIRS-Nbar-Ndvi-Rolling-Tile_Nov_2012_CCR1700
GridIP-VIIRS-Qst-Lwm-Quarterly-Tile_Apr_2014_CCR1700
GridIP-VIIRS-Qst-Quarterly-Tile_Apr_2014_CCR1700
GridIP-VIIRS-Snow-Ice-Cover-Rolling-Tile_Nov_2012
Terrain-Eco-ANC-Tile

Proposed Enterprise Concept

Proposed Enterprise Gridding:

- Offline/post-processing
- No Rolling Tiles
- Using the same mapping method for all Enterprise Land products
- Using the same map projection for all Enterprise Land products
- Derived products could be calculated on gridded level if the following applicable:
  - only one satellite measurement is assigned to grid cell
  - no neighboring pixels are involved in calculations
  - derived product is not used downstream on pixel/granule level
- If needed, back to the operational system with desired frequency (one day, 17 days, one month, 3 months, one year)
- Apply consistency check – much desired for models implementations
- Add more derived gridded products

Proposed Enterprise Concept



Proposed Enterprise Concept

Number of products already exist in gridded form outside of IDPS either as offline version or implemented in NDE:

- Green Vegetation Fraction (GVF)
- Vegetation Health Product
- Surface Type (ST)
- Land Surface Temperature (LST)
- Surface Albedo (SA)
- Snow (binary snow map, SF)

Algorithm/product Challenge

- Existing NDE/offline gridded products have:
  - different resolution
  - different map projection
  - different software language
  - different compositing scheme

Proposed Enterprise Concept

	LSA	LST	GVF	ST	VHP	Snow/Ice
Resolution of offline/NDE version	0.009	0.009	0.009/ 0.036	1km		0.01
projection	Sin	lat/lon	Lat/lon	Sin	Lat/lon	Lat/lon
Mapping method	NN	NN	NN	NN	NN	NN
Data selection criteria		Max – day, min – night	Best satel angle			Clouds clear
Time window		Twice a day	7 days	8 days, 32 days		Last available
Code language	IDL/ENVI	IDL	C++	C, C++		Fortran
If IDPS version exists	yes	no	no	Always been offline	no	yes
If offline/NDE version exists	Dev	Dev	NDE	Always been offline	NDE	Dev
If gridded product needs to go back for retrievals	no	no	no	Once a year	No	?
Users	NCEP	NCEP	NCEP	NCEP		

Proposed Enterprise Concept

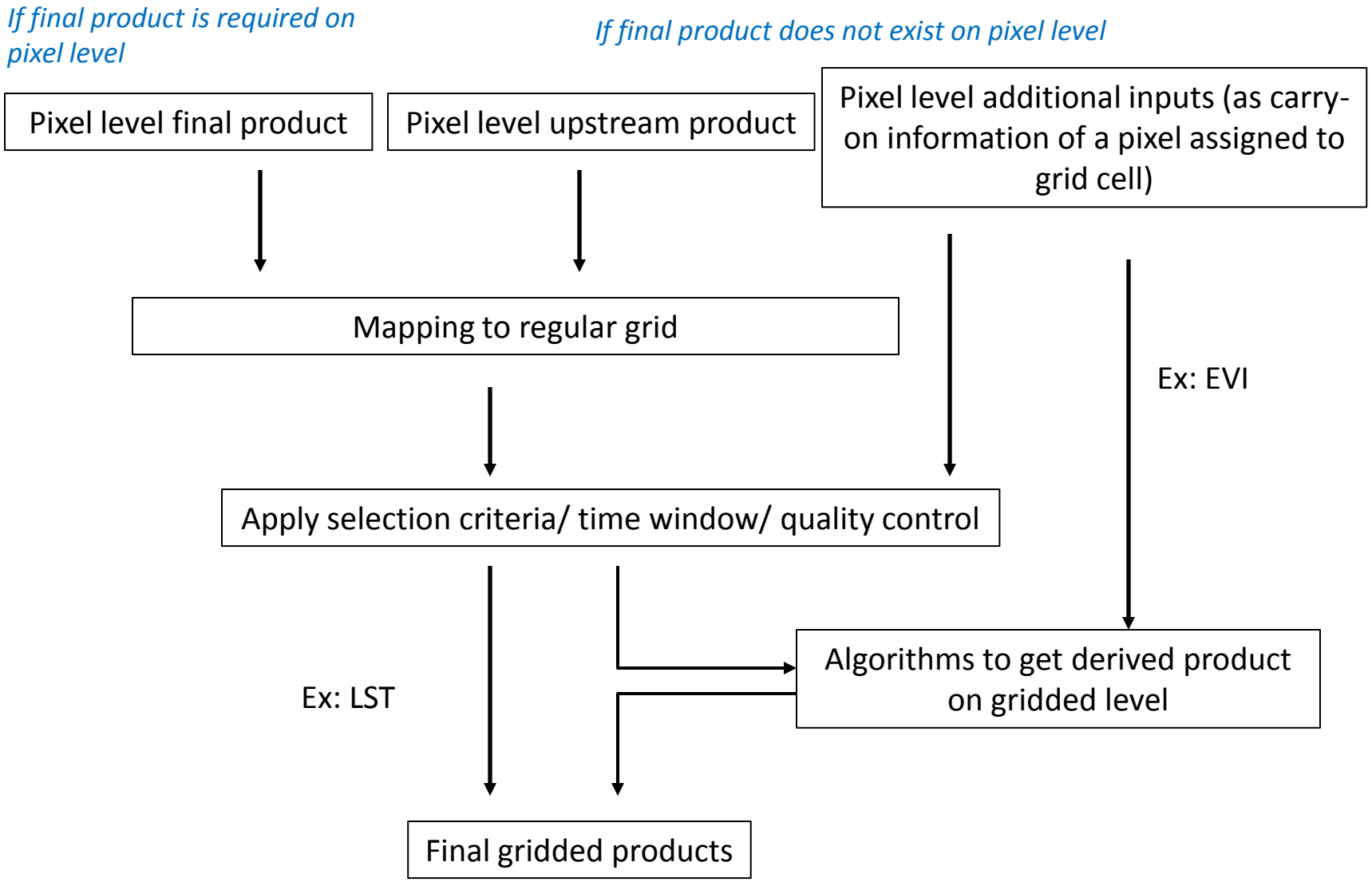
	DSR	SR/BT/VI monthly	NDVI-TOA	NDVI-TOC	EVI	LAI
Resolution	Same as GVF		same as GVF	Same as GVF	Same as GVF	Same as GVF
projection	Lat/lon		Lat/lon	Lat/lon	Lat/lon	
Mapping method	NN		NN	NN	NN	
Data selection criteria						
Time window	One day				7 days	
Code language	C++				C++	
If IDPS version exists	Yes	yes	no	no	no	no
If offline/NDE version exists	Part of GVF	SR within Surf Type			Part of GVF	
If gridded product needs to go back for retrievals	No		no	no	no	no
Users						NCEP

Proposed Enterprise Concept

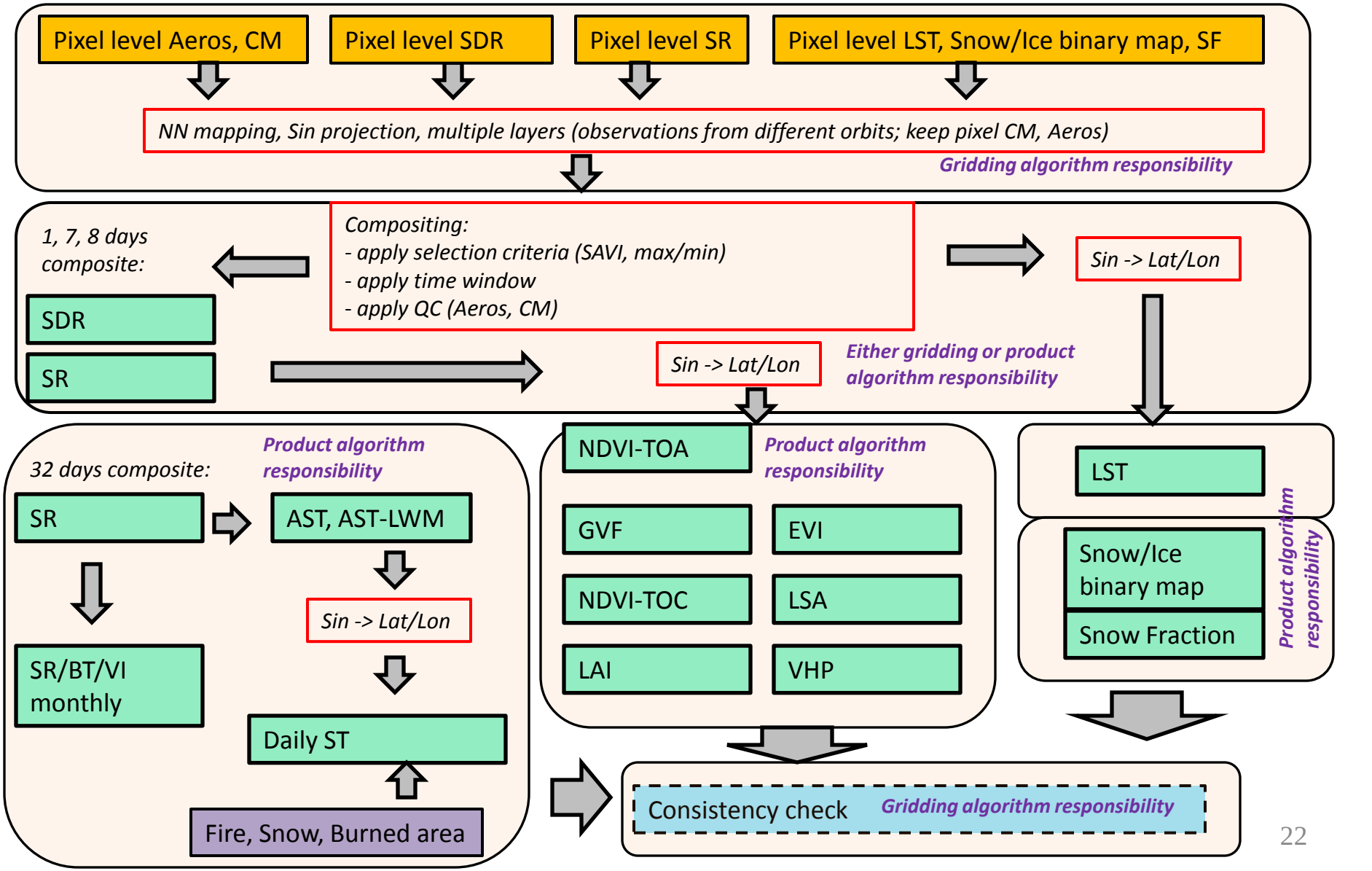
Proposed Enterprise Gridding solutions:

- Sinusoidal 1 km map projection for intermediate products
- Re-project final product to lat/lon if needed
- 0.009 deg lat/lon for final gridded product
- Apply nearest neighbor method initially, possibly GWN later
- Apply best satellite angle criteria if multiple orbits involved (if applicable for the product, e.g. LST requires different approach)
- Combine all SR based products in one stream – no duplicate processing

Proposed Enterprise Concept



Proposed Enterprise Concept

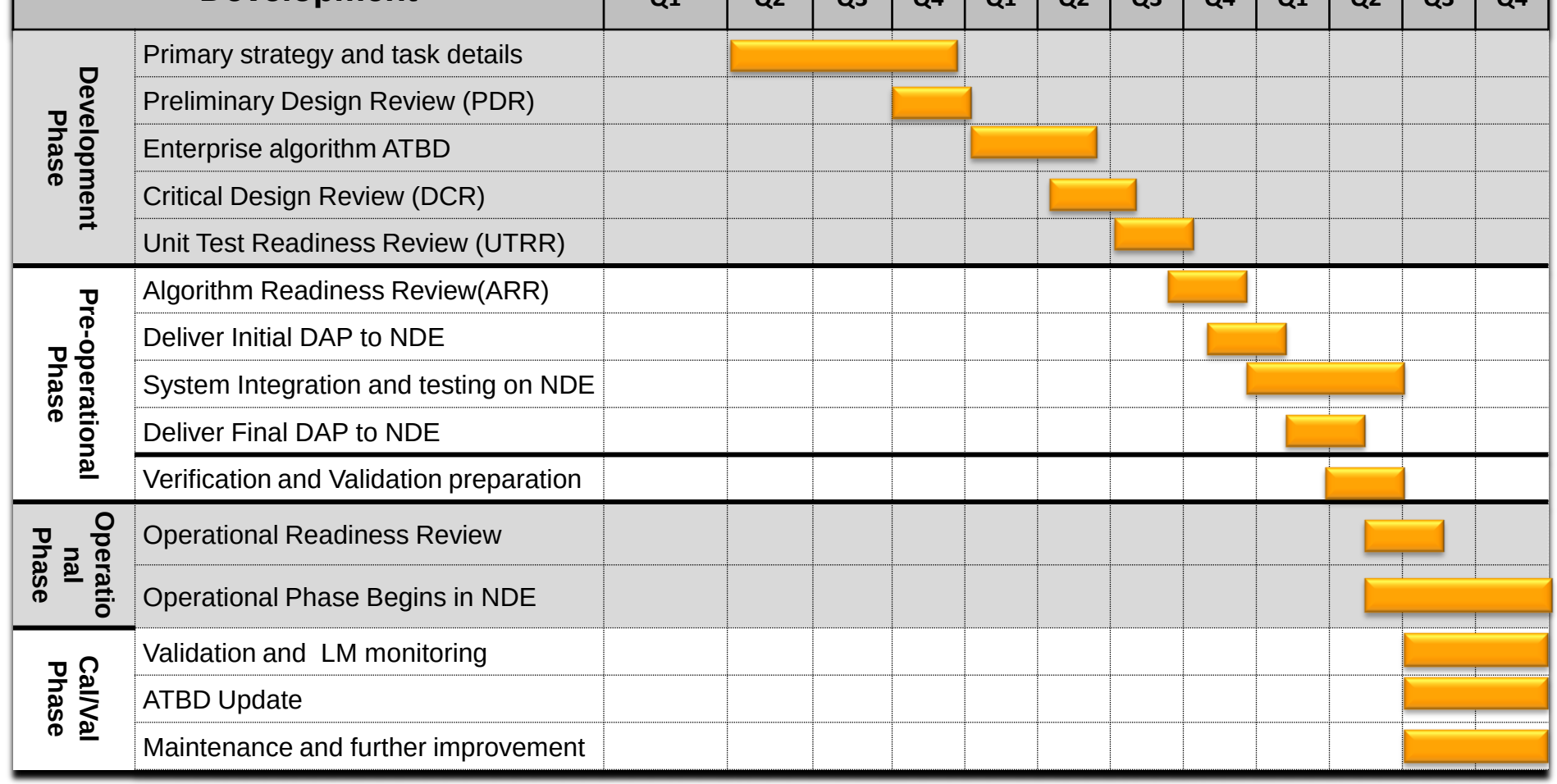


Testing and Validation

How will product be tested/validated

- Intermediate composite product:
  - Comparison with existing NDE products
  - Cross satellite comparison
- Final gridded product
  - Validation by science teams

Schedules and Milestones



Risks

Potential risks

- Despite number of gridded products already exist in operations the unification process has not been started yet and could be time consuming
- Changes will require to be implemented in existing operational gridding products
- Consistency check algorithm development hasn't started yet and could be challenging

Summary and Recommendations

Summary

- Top level design for enterprise land gridded products has been discussed with teams leads
- Common grid resolution and map projection have been determined
- Nearest Neighbor method will be applied initially
- Greatest Weighted Neighbor method will be tested at second stage
- Consistency check is required for NWP implementations

Recommendations

- Provide common software for pixel-to-grid mapping and compositing
- Beyond mapping and compositing, process different products in separate streams:
  - VI related
  - Surface Type
  - Surface Albedo
  - LST
  - Snow/Ice