

2. Overview of WRF Program Status

WRF Executive Oversight Board

Meeting 2

30 July 2004

A Three-phase Strategy

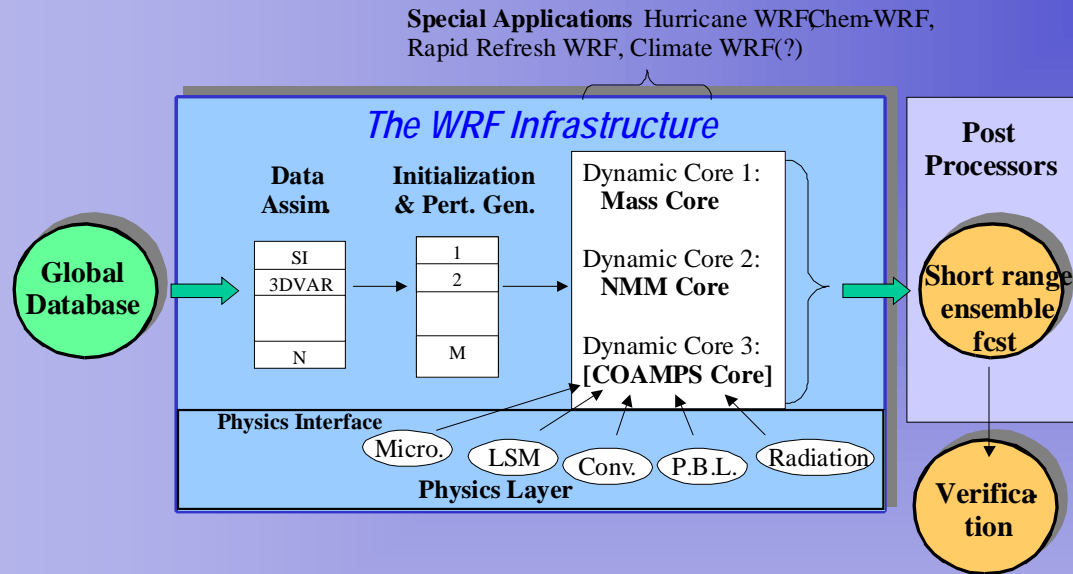
- **Phase 1**: **Develop and implement** WRF as the next-generation mesoscale NWP modeling system, infrastructure and process...
 - To activate inter-organizational collaborations between research and operations
 - To streamline the transfer of new science into both research and operations
- **Phase 2**: Use the WRF process and infrastructure to **sustain** the flow of new science and technology into the WRF modeling system to improve operations and to open new research opportunities
- **Phase 3**: **Extend** the WRF collaboration into other modeling areas of mutual interest—e.g., Ocean modeling, Global modeling, Diagnostic and Statistical post-processing

Phase 1 Goals

1. **Establish a common modeling infrastructure** that facilitates inter-organizational collaboration for the development and transfer of new science into a common WRF mesoscale modeling system for research and operations
2. **Create and release WRF** as the next-generation mesoscale NWP modeling system supported to the **research community**
3. **Implement WRF** model and infrastructure as the next-generation mesoscale NWP system used **in operations**
4. **Create a sustainable repeatable process** that facilitates inter-organizational collaboration to develop and transfer new science into the common mesoscale NWP modeling infrastructure
5. **Develop a plan for Phases 2 and 3**

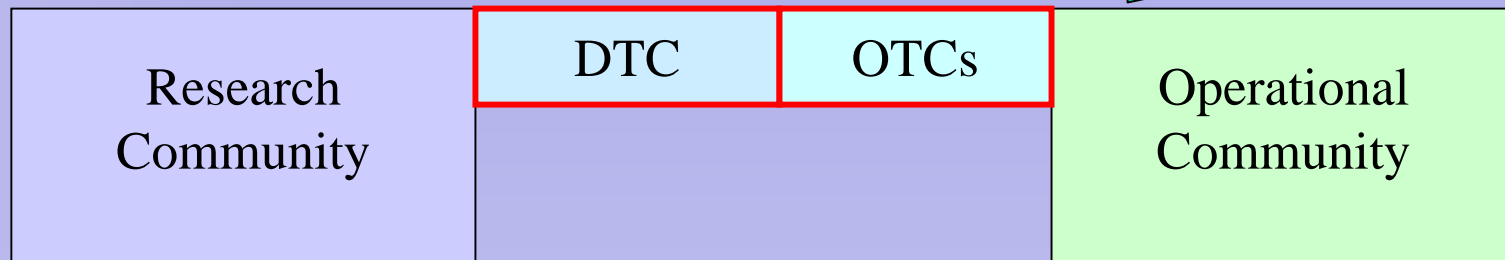
The WRF Modeling Infrastructure is two-fold

1a. WRF Software Infrastructure :



1b. Organizational Infrastructure:

New Science and Technology



Status of Desired Outcomes – Phase 1, Goal 1a

“A common WRF modeling infrastructure established that provides interoperability to the WRF system at level of...”

- “Software Infrastructure, allowing...
 - Input/output-field exchange (Threshold)
 - Physics exchange (Threshold)
 - Dynamic-core exchange (Objective)...among WRF participants.”

<u>Capability Metrics</u>	<u>Status</u>	<u>Susp.Date</u>
- 2 WRF cores <i>released</i> to NCAR, FSL, NCEP, AFWA, & Univs (T)	Done	Sept '03
- 2 WRF cores <i>released</i> to community as single Reference code, with physics interoperability * (T)	On track	Aug '04
- I/O interoperability between COAMPS and WRF Reference code (T)	Discuss'n	TBD
- Physics interoperability between COAMPS and WRF (O)	Pending	TBD
- Core interoperability: 3 WRF cores released to community as single Reference code (O)	Pending	TBD

* *Blue* indicates progress since WRF ExOb mtg. of 1 Dec '03

Status of Desired Outcomes – Phase 1, Goal 1b

“A common WRF modeling infrastructure established that provides interoperability to the WRF system at level of...”

- “Organizational Infrastructure that...
 - Defines institutional roles of DTC and OTCs (*Threshold*)
 - Establishes common DTC (*Objective*)
 - Establish OTCs (NCEP + shared DoD).” (*Objective*)

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
- DoD OTC proposal submitted and approved (T)	Done	Apr '03
- DTC (Central) proposal approved (T)	Done	Mar '04
- DTC functional (O)	Done	Mar '04
- Distributed-DTC TORs written and approved (T)	In Progress	Sep '04
- Distributed DTC functional (O)	Pending	TBD
- OTC functional at DoD (AFWA/FNMOC) (O)		
- AFWA	Done	Jul '04
- FNMOC	In Progress	Sep '04
- NCEP OTC proposal submitted and approved (T)	Delayed	Oct '04
- OTC functional at NCEP (O)	Pending	TBD

Status of Desired Outcomes – Phase 1, Goal 2

“WRF modeling system **created and released to the research community** at a level that defines and supports...”

- “Reference code for **one core** to the research community (*Threshold*)
- Reference code for **three cores** to the research community.” (*Objective*)

<u>Capability Metrics</u>	<u>Status</u>	<u>Susp.Date</u>
- Eulerian mass core (WRFv1.0) in code repository (Reference code) and supported to community (T)	Done	Jun '03
- WRFv2.0 Advanced Research WRF (ARW) Reference code with two-way grid nesting supported to community (tutorial) (T)	Done	May '04
- One core supported with grid and obs nudging (T)	On track	Jun '05
- WRF Reference code with two cores supported to community (O) (tutorial)	On track	Jun '05
- WRF with two-way grid nesting for two cores supported to community (O) (documentation + tutorial)	On track	Dec '05
- WRF with three cores supported to community (O) (documentation + tutorial)	Pending	TBD

Status of Desired Outcomes – Phase 1, Goal 3

“WRF model and infrastructure **implemented** as the next-generation mesoscale NWP system used **in operations ...**”

- “... At 2 operational NWP centers (Threshold)
- At all three operational NWP centers.” (Objective)

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
- <i>End-to-end real time WRF experimental systems running daily at NCEP and AFWA (T)</i>	<i>Done</i>	<i>Oct '03</i>
- <i>DTC retrospective testing of WRF completed and statistics available (as per WRF Test Plan) (T)</i>	<i>Done</i>	<i>Jun '04</i>
- <i>WRF (two cores) implemented operationally at NCEP in Hi-Res Window domains (T)</i>	<i>On track</i>	<i>Sep '04</i>
- <i>WRF (one core) implemented operationally at AFWA in some domains (T)</i>	<i>On track</i>	<i>Apr '05</i>
- <i>WRF-based COAMPS experimental system running daily at FNMOC (O)</i>	<i>Pending</i>	<i>TBD</i>
- <i>WRF-COAMPS implemented operationally at FNMOC (O)</i>	<i>Pending</i>	<i>TBD</i>

Status of Desired Outcomes – Phase 1, Goal 4

“Sustainable repeatable process created that facilitates inter-organizational collaboration to develop and transition new science into the common mesoscale NWP modeling infrastructure, including...”

- “WRF organization and roles defined (Threshold)
- WRF annual operating plan developed (Threshold)
- WRF 5-Year plan developed (Threshold)
- WRF resource plan defined.” (Objective)

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
- DTC and NCEP-OTC organization and roles proposed (T)	Done	Dec '03
- WRF program Management Plan approved by ExOB (T)	Done	Dec '03
- WRF Management charters (roles) & appointments approved (T)	On track	Aug '04
- WRF FY05 annual operating plan developed & approved (T)	On track	Aug '04
- Preliminary WRF 5-Year Plan developed and submitted (T)	Pending	Mar '05
- Comprehensive WRF 5-Year Plan developed and submitted (T)	Pending	Nov '05
- WRF interagency resource plan defined (O)	Pending	TBD

Status of Desired Outcomes – Phase 1, Goal 5

‘Plan for **Phases 2** and 3 developed, including...

- Significant deficiencies identified and prioritized in Phase 1 WRF modeling system, common modeling infrastructure and process *(threshold)*
- Strategy, roadmap and resource plans developed for each *(threshold)*
- At least one cycle of improvement executed to demonstrate repeatability
 - for one of three areas *(threshold)*
 - for all three areas *(objective)*
- Funding strategy identified to entrain university community
 - strategy developed *(threshold)*
 - strategy implemented *(objective)*

Capability Metrics

<u>Capability Metrics</u>	<u>Status</u>	<u>Susp.Date</u>
- Critical deficiency identified in WRF infrastructure (T)	<i>Done</i>	<i>Jul '03</i>
- Strategy, roadmap and resource plan developed for infrastructure documentation, training and code streamlining (T)	<i>Done</i>	<i>Sep '03</i>
- Infrastructure training held for WRF signatories (T)	<i>Done</i>	<i>Jan '04</i>
- Infrastructure documentation draft complete (T)	<i>On track</i>	<i>Oct '04</i>
- Infrastructure documentation finished & released (T)	<i>On track</i>	<i>Dec '04</i>
- Infrastructure streamlining strategy developed (T)	<i>Underway</i>	<i>Oct '04</i>
- Infrastructure streamlining completed (T)	<i>Pending</i>	<i>TBD</i>
- Infrastructure “understudy” position fully functional (T)	<i>Delayed</i>	<i>May '05</i>
- Funding strategy developed to entrain universities (T)	<i>Done</i>	<i>Jul '04</i>

Phase 2: Critical Deficiency Identified

- “The WRF **Software Infrastructure** is complex, difficult for new users to understand, lacks in-depth documentation, and is fully known to only one person (single point of failure)”

ExOB Mtg., 1 Dec 2003

Goals for Alleviating Infrastructure Deficiency

1 Dec 2003

1. **Modify existing WRF Software Infrastructure** to enhance its functionality, usability and extensibility in sync with an ESMF end state
2. **Provide second full-depth expert** for WRF infrastructure support to alleviate “single point of failure”
3. **Publish developer-level documentation** that enables experienced programmers to implement & extend WRF codes for research and operations.
4. **Upgrade user support services** through WRF infrastructure problem-logging and “help-desk”
5. **Establish infrastructure training** for new and advanced users

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 1

- “WRF **Software Infrastructure is modified** to provide different levels of complexity necessary to satisfy different functions, such that...
 - Current infrastructure is **optimized for run-time efficiency** (*Threshold*)
for two cores, maintaining flexibility for research users
 - Infrastructure is **streamlined/rewritten** to enhance usability (*Threshold*)
for advanced users, with efficiency & threshold functionality
 - Infrastructure is **extended** to establish compatibility with (*Objective*)
ESMF standards and linkage to global capability”

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Two WRF cores in current infrastructure optimized for run time efficiency (T)</i>	<i>On track</i>	<i>Dec. '04</i>
<i>- Plan developed to rewrite a streamlined WRF infrastructure that maintains efficiency & threshold functionality (T)</i>	<i>In discussion</i>	<i>Sep '04</i>
<i>- Efficient, more understandable, streamlined infrastructure completed (T)</i>	<i>Pending</i>	<i>TBD</i>
<i>- Plan developed to extend WRF infrastructure to establish compatibility with ESMF standards and linkage to global capability (O)</i>	<i>Pending</i>	<i>TBD</i>
<i>- WRF infrastructure extended to be ESMF compliant and supporting global capability (O)</i>	<i>Pending</i>	<i>TBD</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 2

“**Second full-depth expert provided** for WRF infrastructure support to alleviate single point of failure by...

- Hiring infrastructure understudy at DTC *(Threshold)*
- Having infrastructure understudy fully trained and able to provide range of user support *(Threshold)*
- Having infrastructure understudy train others at OPCs and partner research labs to establish local full-depth infrastructure expertise” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Infrastructure understudy hired and on site at DTC (T) (original target: Feb '04)</i>	<i>Offer made</i>	<i>Jul. '04</i>
<i>- Infrastructure understudy fully trained and able to provide range of user support (T) (original target: Dec. '04)</i>	<i>Pending</i>	<i>May '05</i>
<i>- Full-depth infrastructure expertise established at two OPCs and two partner research labs (O)</i>	<i>Pending</i>	<i>TBD</i>
<i>- Full-depth infrastructure expertise established at three OPCs and all signatory research labs (O)</i>	<i>Pending</i>	<i>TBD</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 3

“**Developer-level documentation published** that enables experienced programmers to implement & extend WRF codes for research and operations, by...

- Completing draft version of WRF Infrastructure developer-level documentation *(Threshold)*
- Completing final version of WRF infrastructure developer-level documentation reviewed and published” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Draft version of WRF infrastructure developer-level documentation completed (T) (original target: Jul'04)</i>	<i>On track</i>	<i>Sep. '04</i>
<i>- Final version of WRF infrastructure developer-level documentation completed, reviewed and published (original target: Oct '04)</i>	<i>On track</i>	<i>Dec. '04</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 4

“WRF **problem-logging and ‘help-desk’** support services upgraded for users,
by...

- Establishing routine call-in support for users of the WRF infrastructure via “understudy” *(Threshold)*
- Establishing enhanced on-line web site for logging user problems & coordinating assistance on infrastructure issues” *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Routine call-in support established for users of the WRF infrastructure (T)</i>	<i>Pending</i>	<i>May '05</i>
<i>- On-line web site enhanced for logging user problems and coordinating assistance on infrastructure issues (O)</i>	<i>Pending</i>	<i>TBD</i>

Status of Desired Outcomes for Phase 2: Alleviating Infrastructure Deficiency – Goal 5

“**Infrastructure training established** for new and advanced WRF users,
by...

- **Completing a special WRF infrastructure training workshop for at least one group of users** *(Threshold)*
- **Establishing routinely scheduled tutorial classes for training in the WRF infrastructure”** *(Objective)*

<i>Capability Metrics</i>	<i>Status</i>	<i>Susp.Date</i>
<i>- Special training workshop on the WRF infrastructure completed for one group of users (T)</i>	<i>Done</i>	<i>Jan '04</i>
<i>- Routinely scheduled tutorial classes established for training in the WRF infrastructure (O)</i>	<i>Pending</i>	<i>TBD</i>

Phase 2 Goals

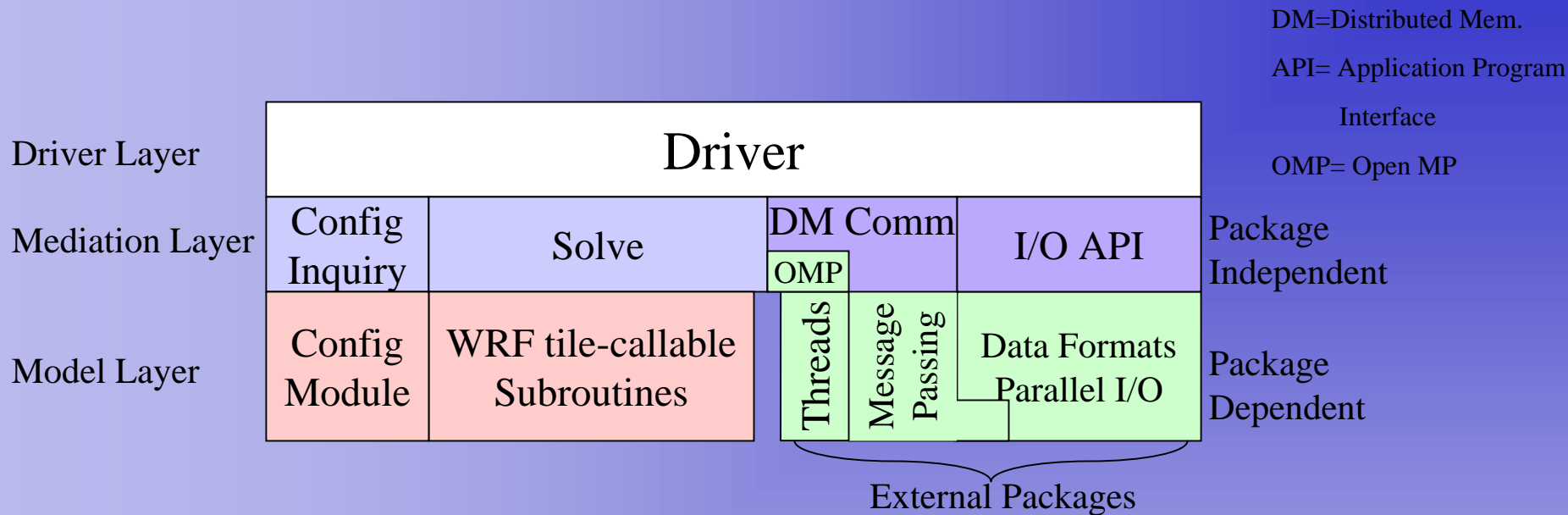
Use the WRF **process** and **infrastructure** to infuse and sustain the flow of new science and technology into the WRF mesoscale NWP **modeling system** to improve operations and to open new research opportunities:

- Identify significant **deficiencies** in Phase 1 WRF **modeling system**, common modeling **infrastructure** and **process**
- Develop strategy, roadmap and resource plan for each
- Execute at least one cycle of improvement in **all three areas** to demonstrate repeatability

Immediate WRF Program Tasks:

- Produce a unified **WRF Code Management** document by completing/updating existing WRF Coding Conventions (NCAR) and WRF Code Management System (NCEP) documents, including documentation standards (Action: PC, Lead Scientist, Head of Requirements & Transitions Board, DTC director)
- Develop and implement plan to **bring current WRF software into compliance** with WRF Code Management document (Action: PC, Lead Scientist, Head of Requirements & Transitions Board, DTC director)
- Establish **user comment and help forum** through NCAR and DTC (Action: Lead Scientist, DTC director)

The WRF Software Engineering Infrastructure (NCAR):



1. **Objective:** Insulate the scientist from parallelism and other architecture-specific details.
2. **Three-Level Hierarchy:**
 - **Driver Layer:** Responsible for top-level control of initialization, time-stepping, I/O, domain set-up, nesting, domain decomposition, computer processor topologies and other aspects of parallelism
 - **Mediation Layer:** “Glue” between driver and model layers; tiling, communication, time step control; makes driver layer transparent to model layer.
 - **Model Layer:** Subroutines that perform actual model computations; meteorological codes, physics
 - **Package Dependents:** Open MP, parallel I/O libraries, message passing libraries, node thread packages

WRF is Easily Extensible to an End-to-End Ensemble Modeling System

Special Applications: Hurricane WRF, Chem-WRF, Rapid Refresh WRF, Climate WRF(?)

