“INTRODUCTION to DMAP”

Special Topic Seminar

October 2000

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SIMULATING REALITY

Introduction to DMAP

- OBJECTIVE
- What is DMAP?
- Nastran Set Definitions and Structural Matrix Reductions
- Flow of Solution -- Common Subdmaps
- Key Modules
- Where Do I Insert a DMAP
- SSSALTERs
- What is a Qualifier?

PRESENTATION OBJECTIVE

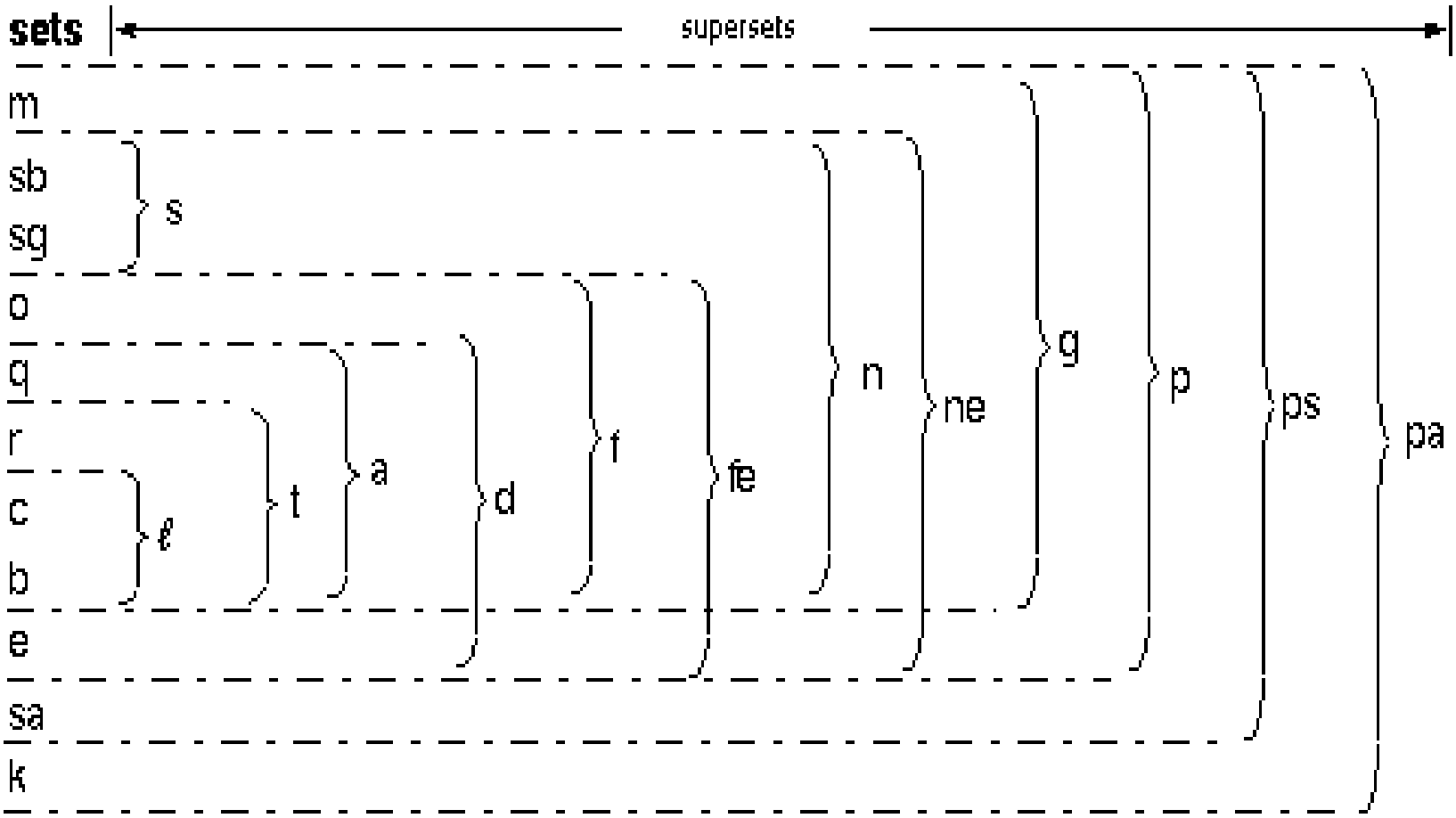
- **Current DMAPpers:**
  - **Reinforce concepts**
  - **Provide a few “tricks”**
  - **Encourage “string based” alters and MALTERs**
- **Potential DMAPpers:**
  - **Introduce NASTRAN set definitions**
  - **Provide insight to the solution process**

What is DMAP?

- DMAP (deemap) Direct Matrix Abstraction Program
  - Developed as “modular” approach to perform linear algebra manipulations on structural matrices
  - MSC.Nastran uses a specific sequence of DMAP statements to solve FEM solutions
- Structured Solution Sequences
  - Subdmaps (similar to subroutines) are collected to perform common tasks
    - Example: SEMG -- Super Element Matrix Generation
      - Used by Sol 101, 103, 105, 106, 111, etc. to assemble the mass, stiffness and other structural matrices for a superelement
    - Helps in writing DMAP ALTERs to modify standard solution

Nastran Set Definitions

Reference: Appendix B, MSC.Nastran Quick Reference Guide



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Structural Set Reductions -- Stiffness matrix

- **Step 1, eliminate dependent dof for MPCs (RBEs)**
  - **Subdmap SEKR0**

Gset = All grids and spoints
Nset = Independent dof
Mset = Dependent dof

$$\left[K_{gg} \right] \Rightarrow \left\{ \begin{array}{c|c} \overline{K}_{nn} & K_{nm} \\ \hline K_{mn} & K_{mm} \end{array} \right\}$$

MCE1 creates Gmn (xformation matrix)
MCE2 creates KNN
KMM is partition

$$[K_{nn}] = [G_{mn}]^T[K_{mm}G_{mn}+K_{mn}] + [K^T_{mn}G_{mn}+\overline{K}_{nn}]$$

Structural Set Reductions -- Stiffness matrix

- **Step 2, partition Single Point Constraints (SPCs)**
  - **Subdmap SEKR**

Nset = Independent dof
Fset = Free dof
Sset = Constrained (SPC) dof

$$[K_{nn}] \Rightarrow \left\{ \begin{array}{c|c} K_{ff} & K_{fs} \\ \hline K_{sf} & K_{ss} \end{array} \right\}$$

This is a simple UPARTN operation

Note: If AUTOSPC is selected, GPSP module checks Knn for Singular stiffness dof, and modifies USET table prior to partition

Structural Set Reductions -- Stiffness matrix

- **Step 3, Static Condensation, Physical dof**
  - **Subdmap SEKR**

Fset = Free dof
Tset = Total set of physical dof (Subset of Aset)
Oset = Omitted dof

$$\left[K_{ff} \right] \Rightarrow \left\{ \begin{array}{c|c} \overline{K}_{tt} & K_{to} \\ \hline K_{ot} & K_{oo} \end{array} \right\}$$

DCMP and FBS solve
$[K_{oo}][G^T_{ot}] = -[K_{ot}]$
for G^T_{ot}

$$[K_{tt}] = [\overline{K}_{tt}] + [K_{ot}][G^T_{ot}]$$

Structural Set Reductions -- Stiffness matrix

- **Step 4, Assemble Aset**
  - **Subdmap SEKMR**

Aset = Assembled (Analysis) set dof
Tset = Total set of physical dof (Subset of Aset)
Qset = Modal dof

$$\left\{\begin{array}{c|c} \mathbf{K_{tt}} & \mathbf{K_{tq}} \\ \hline \mathbf{K_{qt}} & \mathbf{K_{qq}} \end{array}\right\} \Rightarrow \left[\mathbf{K_{aa}}\right]$$

For CMS K_{tq}, K_{qt} are null
M_{tq}, M_{qt} will have coupling terms

Physical dof (Ktt) UMERGEd to Aset Size If Component Modes Synthesis (CMS) is performed, then Qset will exist. CMS performed in subdmap SEMR3

ASET in Statics

- **Further reductions occur on the Aset in statics if inertia relief is present (SUPORT entries)**
  - **See V68 Reference Manual Sections 9.4.1 and 9.4.9 for discussion of inertia relief and Rset**

Tset = Total set of physical dof (same as Aset for statics)
Lset = left-over set
Rset = Reference set (for inertia relief)

$$\left[K_{aa}\right] \Leftrightarrow \left[K_{tt}\right] \Rightarrow \left\{\begin{array}{c|c} K_{ll} & K_{lr} \\ \hline K_{rl} & K_{rr} \end{array}\right\}$$

$$\{P_l\} = [K_{ll}]\{U_l\}$$

ASET in Statics

- **Static Solution messages:**

.f04 file message for solution

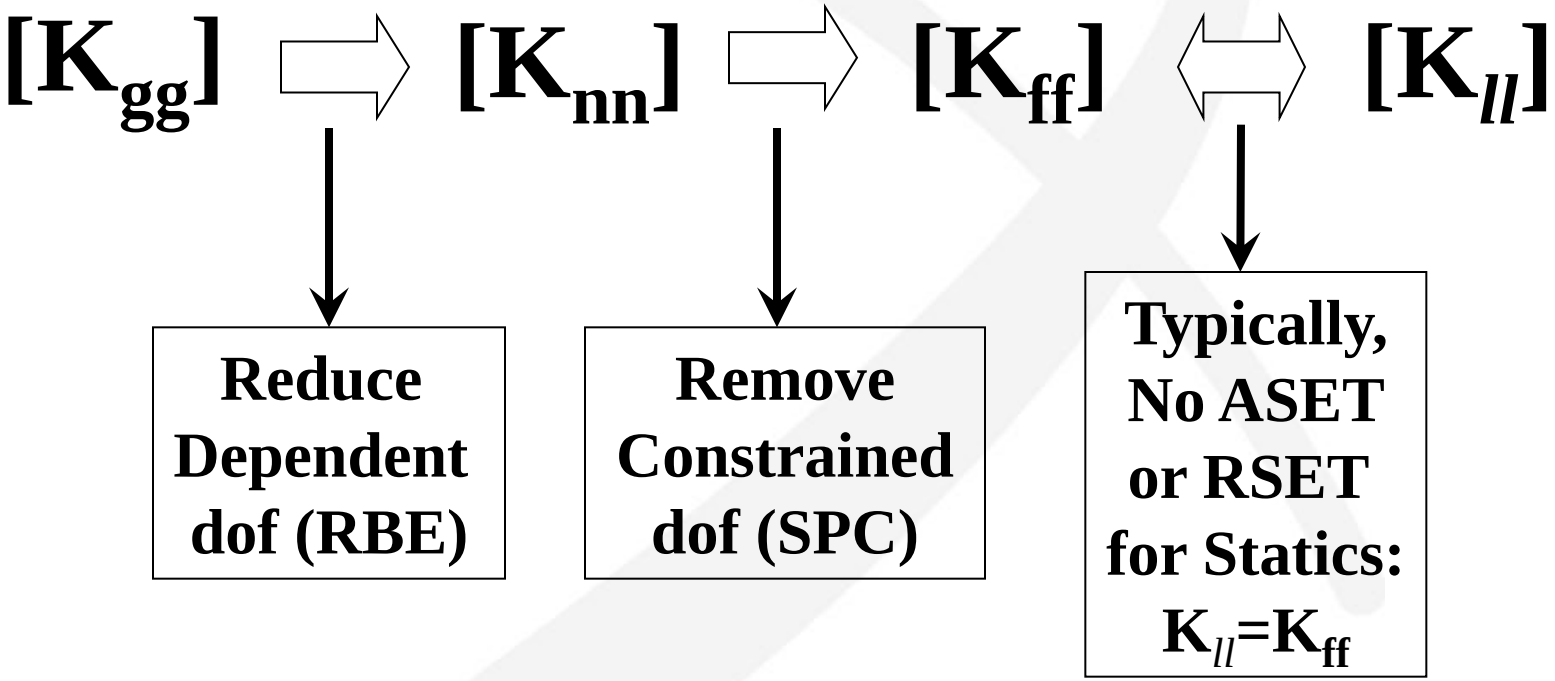
***** USER INFORMATION MESSAGE 4157 (DFMSYN)**
PARAMETERS FOR SPARSE DECOMPOSITION OF DATA BLOCK KLL

.f06 file message for solution

***** SYSTEM INFORMATION MESSAGE 6916 (DFMSYN)**
DECOMP ORDERING METHOD CHOSEN: BEND, ORDERING METHOD USED: BEND
***** USER INFORMATION MESSAGE 5293 (SSG3A)**
FOR DATA BLOCK KLL

LOAD SEQ. NO.	EPSILON	EXTERNAL WORK
1	-6.0279293E-13	1.6411982E+01

Typical Static Solution Sets



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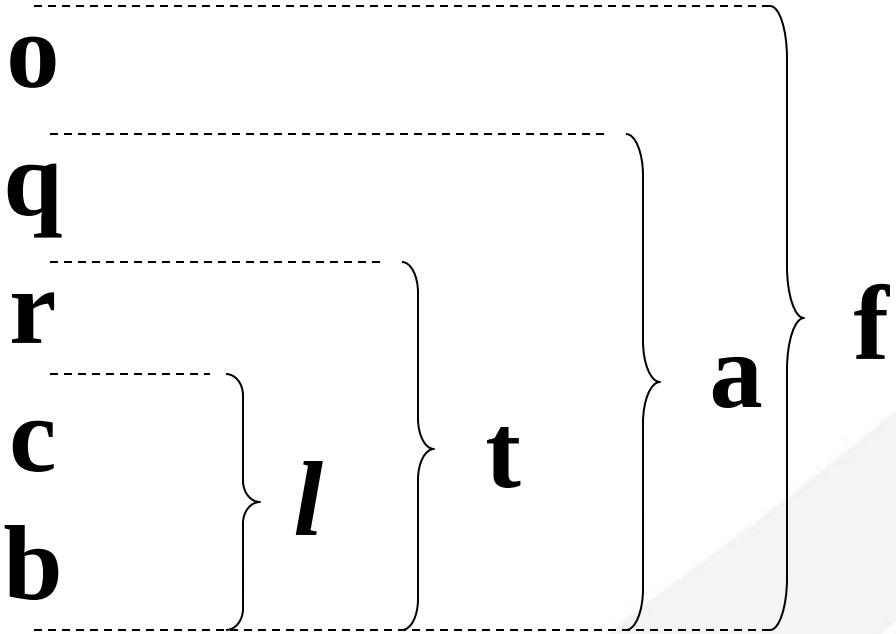
ASET in Normal Modes with Component Modes Synthesis (CMS)

- **Objective: Calculate modal dof and store in K_{qq}, M_{qq}, M_{qt}, M_{tq} (Shown here w/o GDR)**



Bset = dof fixed during CMS
Cset = dof free during CMS
Rset = reference set (used for "clean" rbmodes)

NEW SET FOR CMS:
Vset = Free to Vibrate Set
= o+c+r

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ASET in Normal Modes with Component Modes Synthesis (CMS)

- **Step 1: Partition Vset**

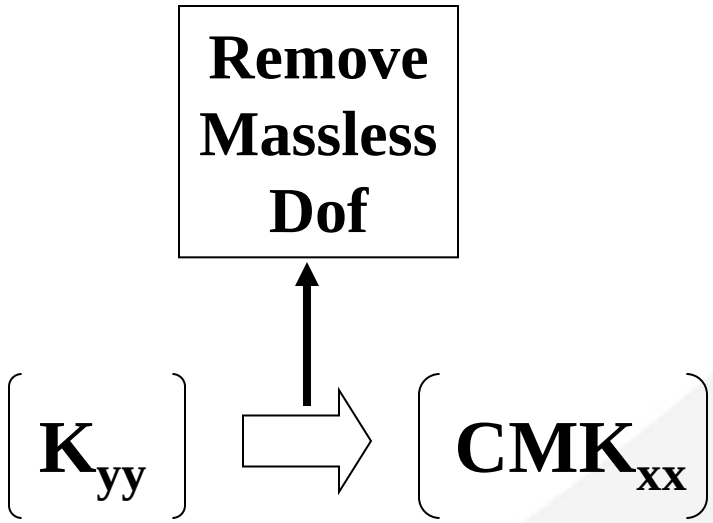
$$\left[K_{ff} \right] \Rightarrow \left\{ \begin{array}{c|c} K_{vv} & K_{vq} \\ \hline K_{qv} & K_{qq} \end{array} \right\}$$

- **Step 2: Perform GDR if requested (never recommended) to form K_{yy}, otherwise $K_{yy} = K_{vv}$**

$$\left[K_{vv} \right] \Leftrightarrow \left[K_{yy} \right]$$

ASET in Normal Modes with Component Modes Synthesis (CMS)

- **Step 3: Remove null rows from mass matrix to form CMK_{xx} and CMM_{xx} , otherwise $K_{vv} = CMK_{xx}$**



Solve Eigensolution CMLAMA, CMPHIXZ

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ASET in Normal Modes with Component Modes Synthesis (CMS)

- **Step 4, Reassemble modal dof into Kaa, Maa**
  - **add residual vectors (static shapes)**
  - **diagonalize Kqq, Mqq**
  - **form Mqt, Mtq**

$$\left\{\begin{array}{c|c} K_{tt} & K_{tq} \\ \hline K_{qt} & K_{qq} \end{array}\right\} \Rightarrow \left[K_{aa}\right]$$

For CMS K_{tq}, K_{qt} are null
M_{tq}, M_{qt} will have coupling terms

Bulk Data Entry
Effect on Set Definitions

Name	Bulk Data Entry Name
m	MPC, MPCADD, MPCAX, POINTAX, RBAR, RBE1, RBE2, RBE3, RROD, RSPLINE, RTRPLT, GMBC, GMSPC*
sb	SPC, SPC1, SPCADD, SPCAX, FLSYM, GMSPC*, BNDGRID, (PARAM,AUTOSPC,YES)
sg	GRID, GRIDB, GRDSET (PS field)
o	OMIT, OMIT1, OMITAX, GRID (SEID field), SESET
q	QSET, QSET1
r	SUPORT, SUPORT1, SUPAX
c	CSET, CSET1
b	BSET, BSET1
e	EPOINT
sa	CAEROi
k	CAEROi
a	ASET, ASET1, Superelement exterior degrees of freedom, CSUPEXT

PRINTING USET DEFINITIONS

- **TO PRINT USET DEFINITIONS IN .F06 FILE:**
  - **PARAM,USETPRT,isort**
    - **-1, no print**
    - **0, internal row sort**
    - **1, internal column sort**
    - **2, internal row & column sort**
    - **10, external row sort**
    - **11, external column sort**
    - **12, external row & column sort**
  - **PARAM, USETSEL,**

V70.5 (and prior) USET DEFINITIONS

Set	Bit No.	Dec Eqiv
U1	31	2147483648
U2	30	1073741824
U3	29	536870912
U4	28	268435456
U5	27	134217728
U6	26	67108864
V	25	33554432
FR	24	16777216
T	23	8388608
Q	22	4194304
B	21	2097152
C	20	1048576
PA	19	524288
K	18	262144
SA	17	131072
PS	16	65536

Set	Bit No.	Dec Eqiv
D	15	32768
FE	14	16384
NE	13	8192
P	12	4096
E	11	2048
SB	10	1024
SG	9	512
L	8	256
A	7	128
F	6	64
NE	5	32
G	4	16
R	3	8
O	2	4
S	1	2
M	0	1

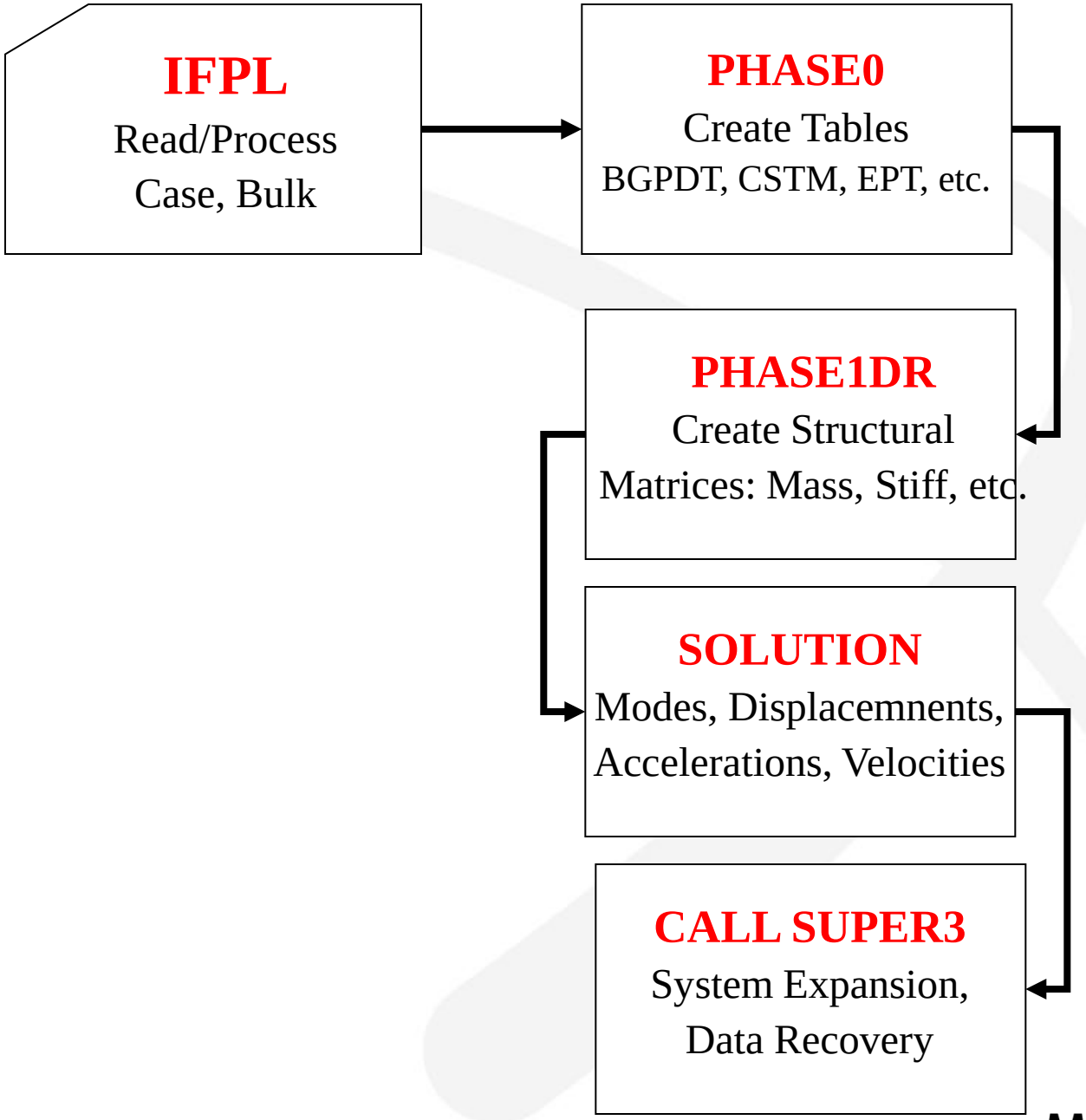
V70.7+ USET DEFINITIONS

Set	Bit	Dec Equiv
U1	31	2147483648
U2	30	1073741824
U3	29	536870912
U4	28	268435456
U5	27	134217728
U6	26	67108864
Q	22	4194304
BE	21	2097152
C	20	1048576
K	18	262144
SA	17	131072
E	11	2048
SB	10	1024
SG	9	512
R	3	8
O	2	4
BF	1	2
M	0	1

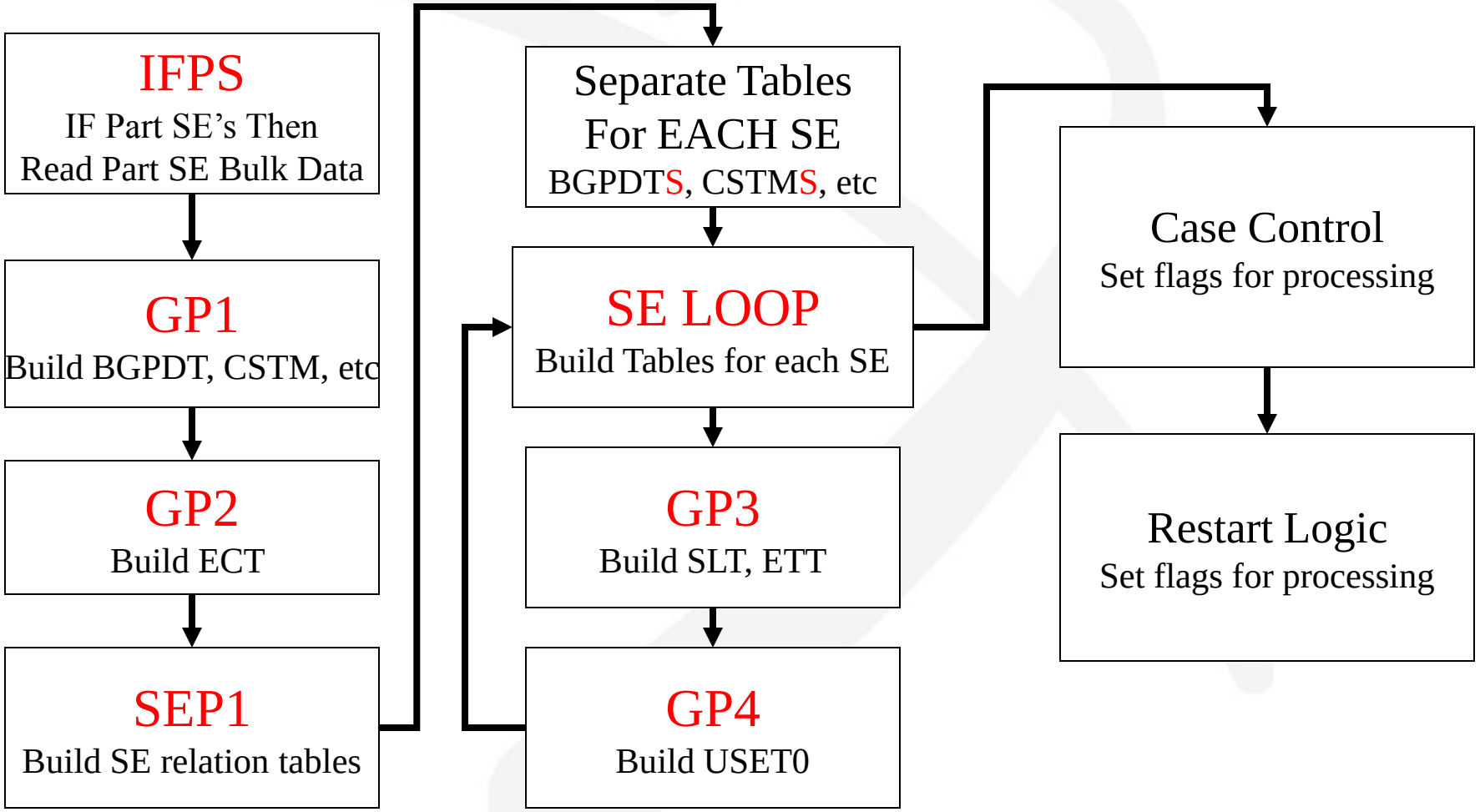
Sets	Dec Eqiv
V=O+R+C	1048588
FR=O+C+BE+BF	3145734
T=R+C+BE+BF	3145738
PA=all sets	7736847
PS=All but K	7474703
D=BE+BF+C+R+Q+E	7342090
FE=BE+BF+C+R+Q+E+O	7342094
NE=BE+BF+C+R+Q+E+O+SB+SG	7343630
P=All but SA and K	7343631
L=BE+BF+C	3145730
A=BE+BF+C+R+Q 7340042	
F=BE+BF+C+R+Q+O	7340046
N=BE+BF+C+R+Q+O+SB+SG	7341582
G=BE+BF+C+R+Q+O+SB+SG+M	7341583

Common Subdmap Flow

- Main DMAP (SESTATIC, SEMODES, SEMTRAN, etc)
  - CALL IFPL
    - Input File Processor Listings
      - Interpret Bulk, Case and Create tables for further processing
  - CALL PHASE0
    - Creates Matrices/Tables for use in creating stiffness, mass, etc.
      - Basic Grid Point Definition Table (BGPDTs), Coordinate System Transformation Matrix (CSTMs), etc.
  - CALL PHASE1DR
    - Builds Structural Matrices for Solution
      - KGG, MGG, BGG | KAA, MAA, BAA, etc.
  - SOLVE for SYSTEM SOLUTION VECTORS
    - SOL 103 -- CALL MODFSRS --
      - solves for LAMA,PHA (eigenvalues, and eigenvectors)
    - SOL 101 -- CALL STATRS --
      - solves for UL = Displacements
  - CALL SUPER3
    - Expand solution, perform data recovery (stress, force, mpcforce, etc.)



PHASE0 Primary Operations



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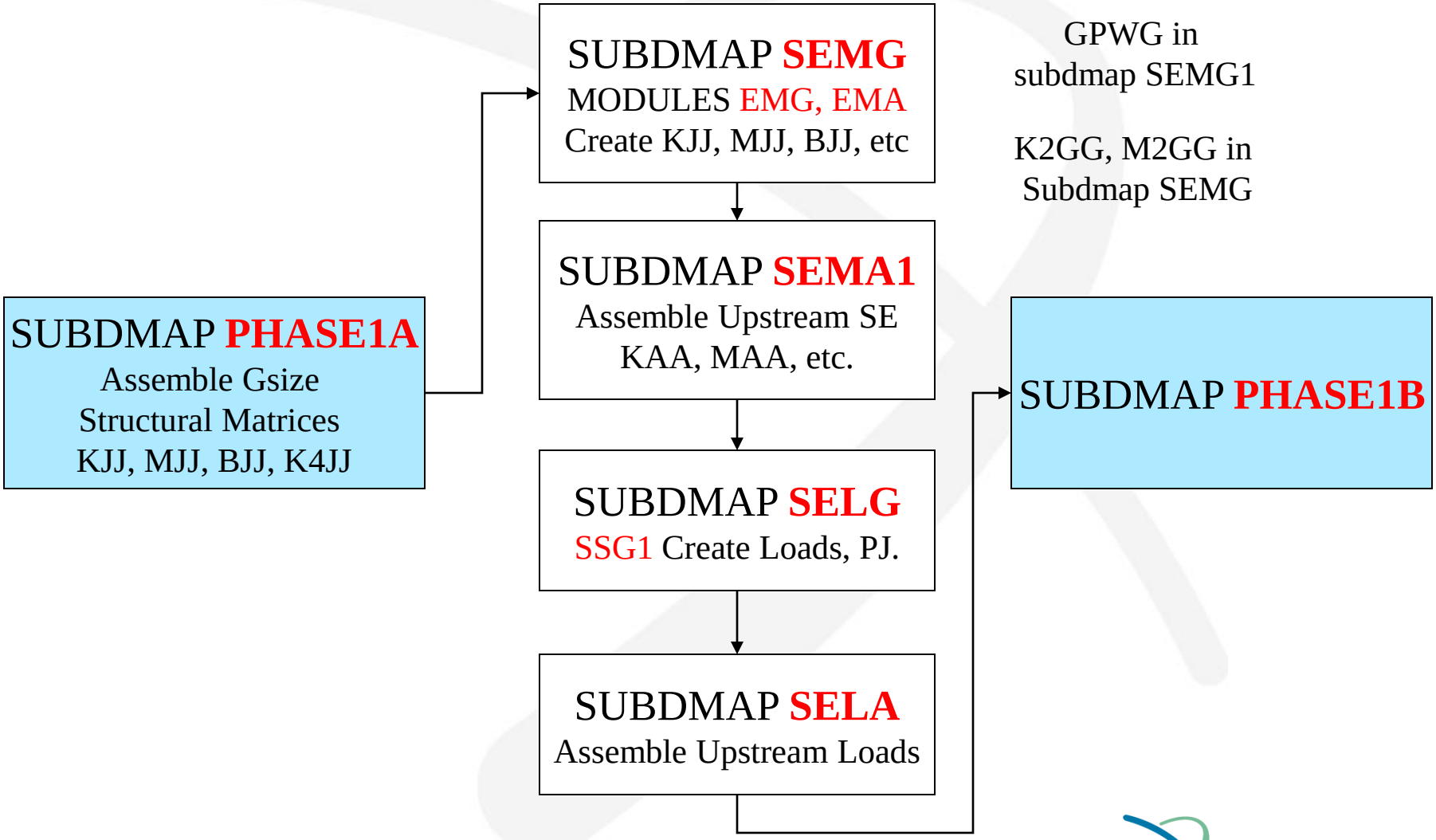
PHASE1DR Primary Operations



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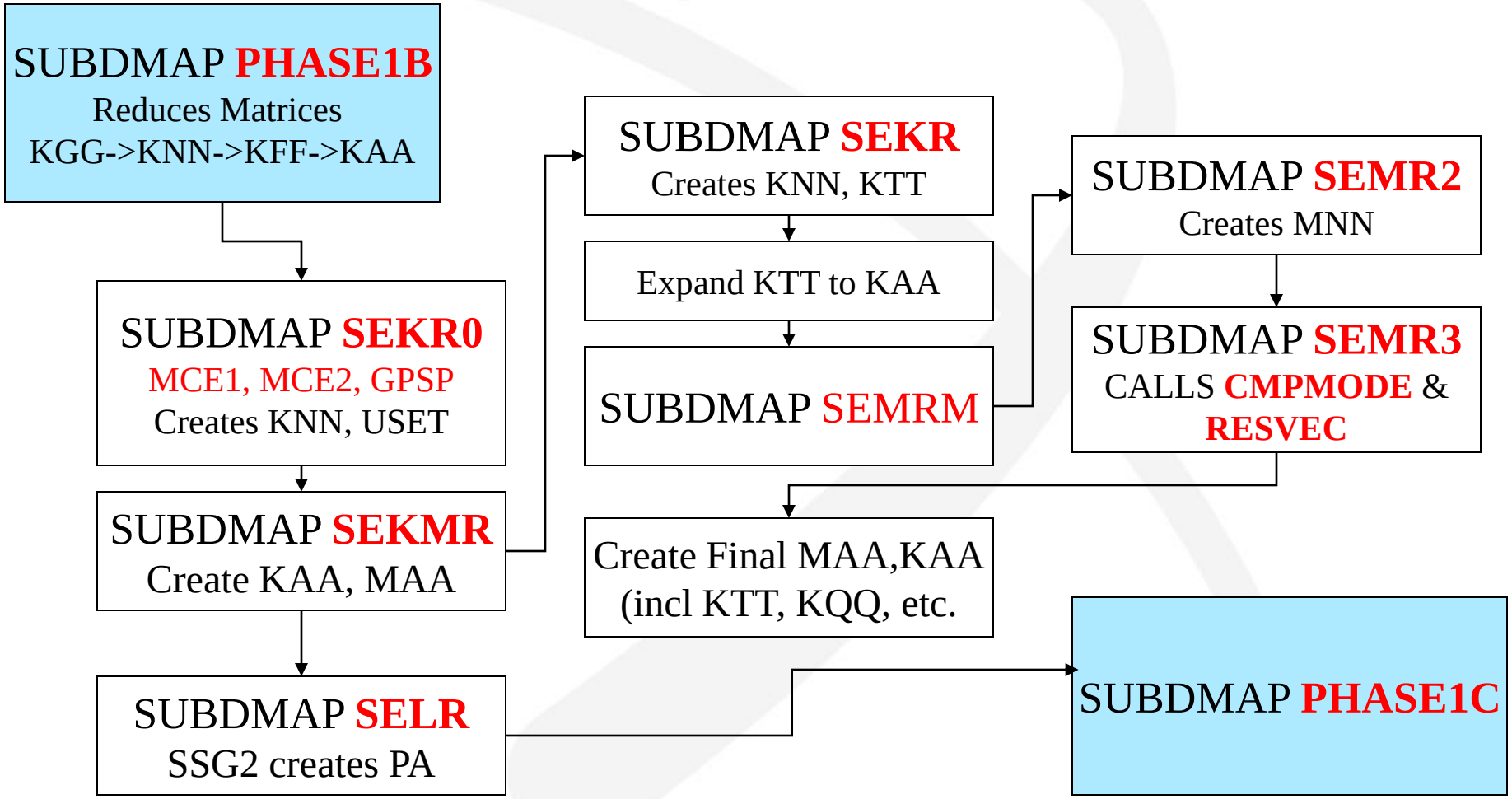
PHASE1DR Primary Operations



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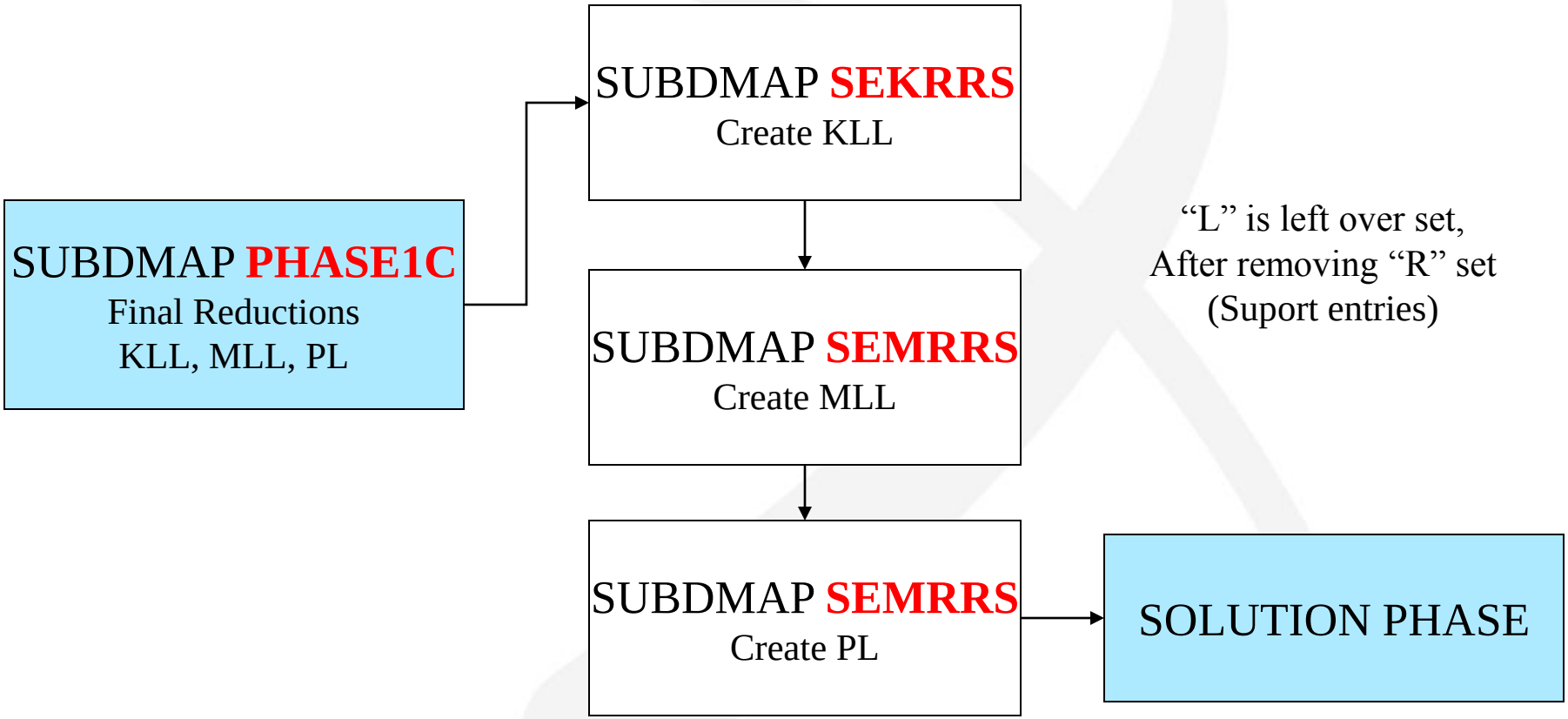
PHASE1DR Primary Operations



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Solution Phase

SESTATIC (SOL 101)

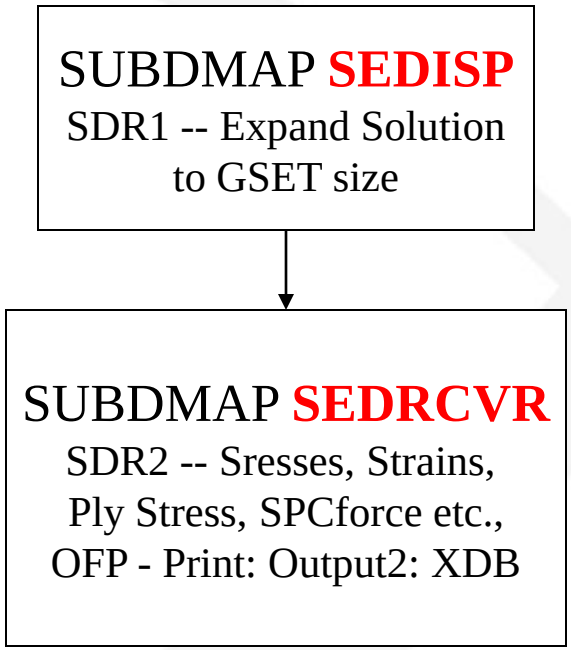
SUBDMAP **STATRS**
Solves for displacements
Create Solution Vector UL

SEMODES (SOL 103)

SUBDMAP **MODEFSRS**
Combines Fluid & Structure
Create Solution Vector PHA

SUBDMAP **MODERS**
READ MODULE for
Eigenvalue solutions

SUPER3 operations



MINIMUM STATIC SOLUTION

```
IFP1   $ case control
XSORT  $ sort bulk data
IFP    $ create geometry
GP1    $ process geometry
GP2    $ element connectivity processing
GP3    $ process static and thermal loads
TA1    $ create element tables
EMG    $ create element stiffness
EMA    $ assemble KGG
GP4    $ create dof table
UPARTN $ partition Kgg to Kff=Kaa=Ktt=Kll
SSG1   $ generate loads
SSG2   $ reduce loads
DCMP   $ decompose stiffness
SSG3   $ for Lset=Aset disp matrix
SDR1   $ expand to Gset disp matrix
SDR2   $ calculate disp, stress, strain, spcf, etc.
OFP    $ print output
END    $ required
```

Only19 lines!!

Barebones Solution

- **Example linear static solution**
  - **Limitations**

```
$ BAREBONES solution for statics
$ stiffness only, no mass
$ MPC/RBE allowed, but no mpcforce data recovery
$ "simple only" -- no checking
$ structural H-elements only (no P-elements)
$ "simple" case control (no output(post), etc.)
$ no k2gg or genel
$ no param,snorm
$ no inertia relief
$ no ASET, BSET, CSET, RSET, QSET, or OMIT
$ no TABLEij processing
$ no MPCForce requests
$ no param,post
$ no composite stresses.
```

Barebones Solution

```
$ ================================
$ read bulk and case control, create tables
$ ================================
IFP1 /CASECC,,,,/S,N,NOGOIFP1/S,N,LASTCC/S,N,BEGSUP $
XSORT,  ,/BULK/S,N,NOGOXSRT $
IFP BULK/
   GEOM1,EPT,MPT,EDT,DIT,DYNAMIC,GEOM2,
   GEOM3,GEOM4,EPTA,UNUSED11,MATPOOL,AXIC,PVT,DMI,
   DMINDX,DTI,DTINDX,DEFUSET,EDOM,DEQATN,DEQIND,
   CONTACT,OINT,UNUSED25/
   S,N,NOGOIFP/S,N,RUNIFP3/S,N,RUNIFP4/
   S,N,RUNIFP5/S,N,RUNIFP6/S,N,RUNIFP7/S,N,RUNIFP8/
   S,N,RUNIFP9/SEID/S,N,RUNMEPT $
```

Barebones Solution

```
$ ==================================
$ basic geometry processing
$ ==================================
GP1 GEOM1,GEOM2,,,,,/
    GPL,EQEXIN,GPDT,CSTM,BGPDT,SIL,/
    S,N,LUSET/S,N,NOCSTM/S,N,NOPOINTS/////-1 $
$ element connectivity processing
GP2 GEOM2,EQEXIN,,,/ECT,/s,n,acoustic $
$ process static and thermal loads
GP3 GEOM3,BGPDT,GEOM2,,,,,/SLT,ETT/
    S,N,NOLOAD/S,N,NOGRAV/S,N,NOTEMP $
$ ==================================
$ combine element data into tables
$ ==================================
TA1 MPT,ECT,EPT,BGPDT,SIL,ETT,CSTM,,,/
    EST,,GEI,GPECT,ESTL,VGFD,/
    LUSET/S,N,NOESTL/S,N,NOSIMP/NOSUP/S,N,NOGENL/-1/// $
```

Barebones Solution

```
$ ==================================
$ generate element stiffness matrix
$ ==================================
EMG EST,CSTM,MPT,,,,ETT,EDT,,,BGPDT,,,,,/
    KELM,KDICT,,,,/ S,N,NOKGG/S,N,NOMGG/
    ////TEMPSID/DEFRMSID/PENFAC //
    //////v,y,K6ROT ///////// S,N,BADMESH $
$ ==================================
$ assemble KGG
$ ==================================
EMA GPECT,KDICT,KELM,BGPDT,SIL,CSTM,,/KGG,// $
```

Barebones Solution

```
$ ==================================
$ create dof table
$ ==================================
GP4 CASECC,GEOM4,EQEXIN,SIL,GPDT,BGPDT,CSTM,,,,GEOM2,/
   RMG,YS0,USET0,/
   LUSET/S,N,NOMSET/S,N,MPCF2/S,N,NOSSET/S,N,NOOSET/
   S,N,NORSET/S,N,NSKIP/S,N,REPEAT/S,N,NOSET/S,N,NOL/
   S,N,NOA/SEID/ALTSHAPE/SEBULK $
```

Barebones Solution

```
$ ==================================
$ reduce out dependent dof
$ ==================================
PURGEX   /GM,,,,/NOMSET $
EQUIVX   KGG/KNN/NOMSET $
IF ( MPCF2>-1 ) THEN $
  UPARTN   USET0,KGG/KMG,,,/'G'/'M'/'N'/1 $
  MCE1     USET0,RMG/GM $
  MCE2     USET0,GM,KGG,,,/KNN,,, $
  UPARTN   USET0,KGG/KMM,,,/'G'/'M'/'N' $
ENDIF $
```

Barebones Solution

```
$ ==================================
$ grid point singularity processor
$ ==================================
GPSP    KNN,KMM,USET0,SIL,GPL,YS0,GEOM4,EQEXIN/
        USET,YS/
        S,N,NOSSET/V,Y,AUTOSPC='YES'/
        V,Y,PRGPST='YES'/V,Y,SPCGEN=0/
        V,Y,EPZERO=1.E-8/0/S,N,SING/V,Y,EPPRT=1.E-8/
        S,N,NOSET/S,N,NGERR/RGTYPE $
```

Barebones Solution

```
$ ====================================
$ spc elimination
$ ====================================
IF (NOSSET<0) THEN
  EQUIVX   KNN/KFF/NOSSET $
ELSE
  UPARTN   USET,KNN/KFF,KSF,KFS,KSS/'N'/'F'/'S' $
ENDIF $
$ ====================================
$ do not allow aset, omit, qset, etc: KFF=KAA=KTT=KLL
$ ====================================
EQUIVX KFF/KLL/ALWAYS $ kll=Left over set
```

Barebones Solution

```
$ ==================================
$ process loads
$ ==================================
LCGEN    CASECC,SLT,ETT/CASESX/0/1 $
SSG1     SLT,BGPDT,CSTM,,EST,MPT,ETT,EDT,,CASESX,,,,,,,/
         PG,PTELEM,/
         V,N,LUSET/V,N,NSKIP $
$ apply constraints to static load vectors
IF (nosset>0) THEN
   SSG2     USET,GM,YS,KFS,,,PG/QR,PO,PS,PA,PL $
ENDIF $
```

Barebones Solution

```
$ ==================================
$ solve...
$ ==================================
DCMP    USET,SIL,EQEXIN,KLL,,/LLL,,LRSEQ/
        1/0/BAILOUT/MAXRATIO/'L'/1.E-20///////
        S,N,SING/S,N,NBRCHG/S,N,ERR=0 $
SSG3    LLL,,KLL,PL,,,,,LRSEQ/
        UL,,RULV,,/V,N,OMIT/
        0/V,N,NSKIP/S,N,EPSI $
$ ==================================
$ expand solution vector (UL) to GSET size
$ ==================================
SDR1    USET,PG,UL,,YS,,GM,PS,KFS,KSS,QR/UG,PGG,QG/
                V,N,NSKIP/'STATICS'/NOSPC $
```

Barebones Solution

```
$ ==================================
$ calculate output requests
$ ==================================
SDR2    CASESX,CSTM,MPT,,EQEXIN,,ETT,EDT,BGPDT,PGG,
        QG,UG,EST,,,,,,,,/
        OPG1,OQG1,OUGV1,OES1,OEF1,/
        'STATICS'/S,N,NOSORT2/V,Y,NOCOMPS=1 $
$ print output
OFP OPG1,OQG1,OUGV1,OES1,OEF1// $
END
```

Selected DMAP Modules

- **LOGICAL CONSTRUCTIONS**
  - **IF - THEN - ELSE - ENDIF -- logical branch**
  - **DO WHILE - ENDDO -- counter loop**
  - **EXIT -- terminates program**
- **READ/WRITE operations**
  - **DMIIN -- process DMI bulk data entries**
  - **DTIIN -- process DTI bulk data entries**
  - **MTRXIN -- process DMIG bulk data entries**
  - **INPUTT2/OUTPUT2 -- read/write tables**
  - **INPUTT4/OUTPUT4 -- read/write matrices**

Selected DMAP Modules

- **PRINTING MATRICES**
  - **MATGPR -- print a matrix and associated dof**
  - **MATPRN -- print matrix (just numbers, no dof map)**
- **PRINTING MESSAGES (very useful)**
  - **MESSAGE -- prints a message to the .f06 file.**
- **INTERROGATING MATRICES**
  - **PARAML**
    - **Extract single value (row,col)**
    - **Get Trailer info**

Selected DMAP Modules

- **PARTITION/MERGE OPERATIONS**
  - **MERGE -- merge matrices using partition vectors**
  - **UMERGE -- merge matrices using USET definitions**
  - **PARTN -- partition matrices using partition vectors**
  - **UPARTN -- partition matrices using USET defs.**
- **MATH OPERATIONS**
  - **ADD -- add, subtract, multiply, divide, 2 matrices**
  - **MPYAD -- matrix multiplication**
  - **SMPYAD -- triple product matrix multiplication**

Selected DMAP Modules

- **SPECIAL MANIPULATIONS**
  - **APPEND -- append 2 matrices (useful in DO loops)**
  - **DIAGONAL -- extract diagonals from a matrix, raise matrix to a power**
  - **EQUIVX -- equivalence datablocks**
  - **MATGEN -- generate various matrices**
    - **Identity, Pattern matrix, psuedorandom matrix, partitioning matrix, null matrix, internal-external sort matrix**
  - **MATMOD -- modify matrices. -- many options.**
  - **VECPLOT -- resultants, transforms, rbmodes**

Selected DMAP Modules

- **“FAVORITE” MODULES**
  - **GP4 -- creates “raw” USET table (USET0)**
  - **GPSP -- AUTOSPC, creates “final” USET table**
  - **GPWG -- Grid Point Weight Generator**

Selected DMAP Modules

- **COMPUTATIONAL MODULES**
  - **DCMP -- decompose a matrix**
  - **FBS -- forward backward substitution**
  - **READ -- eigensolution**
  - **SOLVE -- [A][X]=[B], solve for X -- better to use dcmp & fbs**

WHERE DO I PUT AN “ALTER”?

- **What is a DMAP ALTER?**
  - **The ALTER is a way to modify the standard solution sequence.**
  - **Example -- OUTPUT4 MAA,KAA after CMS:**

THE “ALTER”

Old Style: line number

```
compile phase1dr,nolist,noref
alter 164
output4 maa,kaa,,,//-1/13/1//15 $
```

New Style: String Based

```
OR:
compile phase1dr,nolist,noref
alter ‘malter.*kaa.*maa’
output4 maa,kaa,,,//-1/13/1//15 $
```

String Based (w/o compile!)

```
OR:
malter 'malter.*kaa.*maa'
output4 maa,kaa,,,//-1/13/1//15 $
```

THE “ALTER”

- **What is a “STRING BASED” alter?**
  - **Searches SUBDMAP for unique string rather than line number**
  - **ALTER ‘unique string’(occurance,offset)**
  - **Advantage: 95+% success rate converting from one version to the next.**
- **What is an “MALTER”?**
  - **Searches entire solution sequence for a unique string**
  - **Don’t need to know subdmap name or line number**
  - **“built in” malters**

MALTER:TOP OF PHASE 1 SUPERELEMENT LOOP AFTER PARAMETERS AND
MALTER:QUALIFIERS SET

MALTER:AFTER UPSTREAM SUPERELEMENT MATRIX AND LOAD ASSEMBLY
MALTER:(KGG, BGG, MGG, K4GG, PG)

MALTER:AFTER SUPERELEMENT MATRIX AND LOAD REDUCTION TO A-SET,
MALTER:STATIC AND DYNAMIC (KAA, MAA, BAA, K4AA, PA)

MALTER:BOTTOM OF PHASE 1 SUPERELEMENT LOOP

MALTER:AFTER SUPERELEMENT DISPLACEMENT RECOVERY (UG)

MALTER:BOTTOM OF SUPERELEMENT DATA RECOVERY LOOP

MALTER:AFTER PREFACE MODULES

MALTER:AFTER TOTAL SUPERELEMENT STIFFNESS, VISCOUS DAMPING, AND MASS
MALTER:FORMULATED, STRUCTURAL + DIRECT INPUT (KJJ, BJJ, MJJ)

MALTER:AFTER SUPERELEMENT LOAD GENERATION (PJ)

MALTER:AFTER ELEMENT STRESS, STRAIN, ETC. DATA RECOVERY, SORT1
MALTER:(OUGV1, OES1, OEF1, ETC.)

MALTER:AFTER ELEMENT STRESS, STRAIN, ETC. DATA RECOVERY, SORT2
MALTER:(OUGV2, OES2, OEF2, ETC.)

MALTER:AFTER X2PP MATRICES READ (K2PP, M2PP, B2PP)

MALTER:AFTER SUPERELEMENT STIFFNESS, VISCOUS DAMPING, MASS, AND
MALTER:ELEMENT STRUCTURAL DAMPING GENERATION (KJJZ, BJJX, MJJX, K4JJ)

MALTER:AFTER X2JJ MATRICES READ (K2JJ, M2JJ, B2JJ)

Matrix Trailer

```
*8** Module  DMAP Matrix      Cols      Rows  F T     NzWds     Density
     EMA     110  KJJZ         132       132  6 2       36 8.73508D-02
(continued)
BlockT  StrL   NbrStr    BndAvg    BndMax    NulCol
4     2      621       66        81        22 *8**
```

Word	Contents
1	Number of columns in matrix
2	Number of rows in matrix
3	Form of the matrix
4	Type of matrix
5	Largest number of nonzero words among all columns
6	Density of the matrix multiplied by 10000
7	Size in blocks
8	Maximum string length over all strings
9	Number of strings
10	Average bandwidth
11	Maximum bandwidth
12	Number of null columns

Turn on DIAG,8 in Executive Control Section (after SOL, before CEND)

Matrix Forms & Types

Form	Meaning
1	Square
2	Rectangular
3	Diagonal
4	Lower triangular factor
5	Upper triangular factor
6	Symmetric
8	Identity
9	Pseudoidentity
10	Cholesky factor
11	Trapezoidal factor
13	Sparse lower triangular factor
15	Sparse upper triangular factor

Type	Meaning
1	Real, single precision
2	Real, double precision
3	Complex, single precision
4	Complex, double precision

SSSALTERs

- MSC provides several useful alters as part of the delivery of Nastran.
  - These may already solve the problem you are trying to solve
  - A good source of “go-by” DMAP alters
- SSSALTER location:
  - /msc/msc707/nast/misc/sssalter/*
  - INCLUDE ‘SSSALTERDIR:alternname’
    - SSSALTERDIR is a “symbol” that Nastran understands

SSSALTERs

- Over 60 alters available--see readme file
  - All alters contain a small sample and description
- Commonly used SSSALTERs:
  - checka -- multilevel strain energy checks
  - effmassa -- modal effective mass (sol 103)
  - nlgyroa -- nonlinear gyroscopic effects
  - alter1ha, alter2ha, alter3ha -- coupled loads analysis
  - appenda -- combine eigensolutions
  - delmodea -- remove a mode from solution
  - mfreqea -- contribution of each mode to strain energy

SSSALTERs

- **Commonly used SSSALTERs (cont):**
  - **mica -- initial conditions in modal transient**
  - **modevala -- checks for adequate modal content for a specified load**
  - **oloadcda -- oload resultant in user-specified coord sys**
  - **premaca -- cross ortho & MAC between Gset & Aset**
  - **postmaca -- cross-ortho & MAC between model/test**
  - **sebloada -- dynamic SE interface loads**
  - **spc101a -- separate explicit SPC's from AUTOSPC's**
  - **111_by_modea -- Sol 111 data recovery for indiv. Modes**

What is a Qualifier?

- Qualifiers are used in the Structured Solution Sequences (Sol 101-200) for each datablock
- Example: Qualifiers for KAA
  - KAA will exist on the database for every superelement
  - Nastran must keep track of “which” KAA is being used
  - This is done with qualifiers.

What is a Qualifier?

- **Example: find the datablocks and qualifiers on a MSC.Nastran database (.DBALL/.MASTER):**

```
acquire nddl
assign basedb='dbmaker.MASTER'
dbloc logi=basedb
dbdir
endjob
```

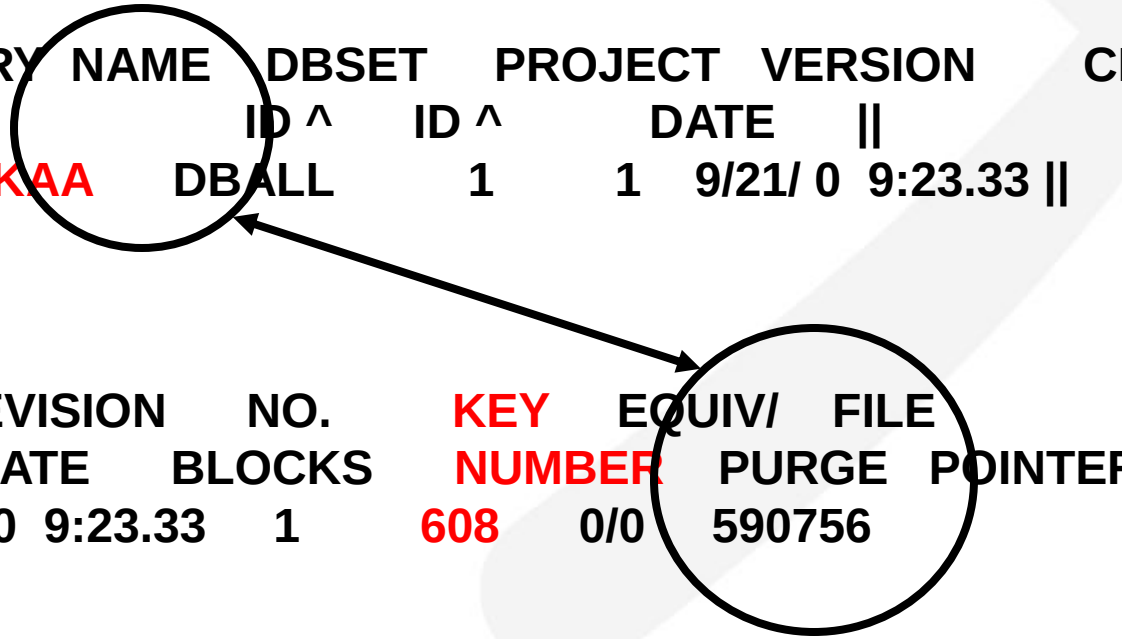
What is a Qualifier?

- **DBDIR listing:**

```
NDDL DATABLOCK LISTING

 ENTRY  NAME    DBSET    PROJECT   VERSION       CREATION    ||
                 ID ^     ID ^         DATE      ||
   68 KAA      DBALL        1         1    9/21/ 0  9:23.33 ||


    REVISION      NO.        KEY     EQUIV/    FILE
      DATE       BLOCKS     NUMBER    PURGE   POINTER
 9/21/ 0  9:23.33    1        608      0/0     590756
```



MSC SOFTWARE
SIMULATING REALITY

What is a Qualifier?

```
KEY NUMBER =   608        QUALIFIER NAME AND VALUE
                    SEID    =          0
                    PEID    =          0
                    MPC     =          0
                    SPC     =          0
                    DYRD    =          0
                    MTEMP   =          0
                    NLOOP   =         -1
                    DESITER =          0
                    PVALID  =          0
                    APRCH   =
                    HIGHQUAL=          0
                    K2GG    =
                    M2GG    =
                    AUXMID  =          0
                    DESINC  =          0
```

What is a Qualifier?

- **Why are qualifiers important**
  - **If DMAP'ing and superelements, then you will need to use the "right" KAA matrix.**
    - **For example, the SPC, MPC, SEID, etc. qualifiers must be correct, or Nastran won't find it, and issue a fatal message**
    - **DBVIEW can be used to get proper matrix**
- **What are some common uses?**
  - **"CSUPER" external superelements**
  - **If reading a file from an external source (i.e. OUTPUT4) and creating a database that will be used in another run, the Qualifiers must be correct.**

Summary

- Nastran Set Definitions and Structural Matrix Reductions
- Flow of Solution -- Common Subdmaps
- “Barebones” dmap solution
- Key Modules
- Where Do I Insert a DMAP (alter, malter)
- SSSALTERs
- What is a Qualifier?