

Design and Implementation of Interactive Electronic Technical Manual Based on XML Object Database

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Abstract

We combine XML and object database technology to develop an interactive electronic technical manual. A technical manual file in XML is fragmented into objects and then stored in an object database having the schema corresponding to the technical manual DTD. Then we develop browsing, indexing and searching functions commonly found in electronic manuals. Furthermore, we build an expert system to assist user make effective use of the content of the manual. The knowledge base of the expert system is constructed by converting the procedural knowledge in the technical manual into production rules. By using the interface, user can then access the technical manual in an interactive way. We have built a prototype system for an engine troubleshooting manual. By means of the expert system interface, user can focus on the questions of specific engine faults troubleshooting and easily find the solutions.

1 Introduction

Paper-based technical manuals are costly to produce and manage, and are incapable of integrating in an automated environment. Their poor usability

We onli reb W brML a d WenXdXj mt oM nbb dXs rMi WeWl
bi tt Me dj eWkg dXs Wj onalnb eod WWh eW ny v Monh
si j mepma dhXW s mMi epmd- Mmmt oM ma bg a d.M
nAMeb dombt nXe MKs mmmM Wl Wenodj eWmmj eoMKY
enjpXYWdna dXi dnffDv T wxFly

v pm enjpXMMic M fDv T t oMi Wnb dX nff j WKe
a nepM rM i bnob eMdjj nbb epmj MKenXeb W d enjpXW
jdna dXi dn, Ely qi oepna Mong Wj dX- mi hns eMj MKL
beoi je da dWenXdXj ma dXdhna nXe bc bena. M enjpXW
jdna dXi dry Pjj Ms Wl eMmmmb M enjpXYWdnbM pW
eWdeWkg dX fDv T udoWb roM s WWWWs t dhm Wl
dhnb rM ri nlt dhms W rdcg pct noenxe s Mj i a nXe fing
beoi jei ons s Mj i a nXeb fiW SGT L/XT L ,x3lsvbeMns
W d nXndlo fing beoi jei ons s Mj i a nXeb a dWedWns
W d XNKLons i Xs dXe omdeWkdM M .njeM W Wens pW
nodj p Wdns ded- dbng dXs fiXdnc eMbeoi jei ons s Mj
i a nXe s ded- dbm Wenhdens L Wp Mepno WcMa deWK
t oM nbb bi jp db nxt noe bc bena ,x Ely

P jMa a MKic i hns mmj eoMKY enjpXYWdna dXi drb W
epmKXmHDLpg hi jp db *Helpmate* ,2lg Lp Wp t oM
uWnb i bnob L Wp epmri XjeWkb M dj qi WWh s Mj l
a nXe j MKenXeb dj j Ms Wl eMepmnKh Wmrdi reb bW l
deWK eMbi t t r: epmM nodeWl bnqi nXj nlg - oM bWl
epmt dodhodt p j MKenXeb dXs flM s Whoda bgi bWl pcl
t norWk beMmmno epna Monj MKenXeb Mf omndens s ned Wg
a M W Wl epms ded- dbmj MKenXeb *etcy* v pmfDv T
enjpXMMic pdb - mX dt t nW W enjpXYWdna dXi dn
di epMWh eMbi hi jp db PfT SS ,x7ly fe i hnb M .nje
s ded- dbmenjpXMMic epde nXd- mb i hno eMhnXnodeng
s W rdcg beMng on oWing di eM deng dXs s mmWno p Wpno
mmmfDv T a nXeWks d- Mny

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fX epW t dt nog LmdW de snumM Wh dX fDv T - dhrs MK XT L M .nje s ded- dbm¹y fX ds s WWK eM t oMi WWh - oM bWhg Ws mx Wh dXs bnlojp Wh ri Xj l eWKhg LmdihM- i W dX nxt noe bcena - c na t nM Wh epmt oM ns i odn kXML ms hm W epmenj pXYdn a dXi dn eM pmt i bnob nAnje Winc dijM t nWp epnW edbky v pm j MnM epmf Dv T bcena WdX XT L M .nje s ded- dbm Lp Wp beMnb epmj MkenXe M epmenj pXYdn a dXi diy OX epm Mnb Wm M epm XT L M .nje s ded- dbm Wepm jM t MknXe MnXenoWh epmenj pXYdn a dXi dn WXT L W eM epm M .nje s ded- dbny NM epe deg W epW t dt nog Lms MXM deena te eM- i W dX di epM Wh eM m rM fDv T y v pi bg Lmfioe j Mkeoi je epmbj pna d j Monh bt Mks Wh eM epm Dv D M epmenj pXYdn a dXi drg dXs epnX rodha nXe epmenj pXYdn a dXi dn XT L fim W eM M .njeb dXs beMm W epms ded- dbny fX ds s WWK eM nXenoWh XT L fim W eM M .nje s ded- dbng LmdihM t oMi W ind a dW enX dX j m W enordj meMnXd- mds a Wl WodeM a M W Wh epmj MkenXe M enj pXYdn a dXi dn roM epms ded- dbny

OX epm Mepno bWm W epmi bn W enordj mjM t M XnXe epde t oMi Wmb i bn L Wp epmdj j nbbWh ri Xj eWkb a nXe Wks d- Mny v pmi bn W enordj mjM t MknXe W ri oepno s W Wns W eM eponmbi - jM t MknXe kn Lms bnlojp W enordj ng- oM bWh W enordj ng dXs W enodj eWm W enordj ny v pm W enodj eWm W enordj mdrMh L Wp epm kXML ms hm- dbmdXs epm W nonXj mnXh W mt oMi Wmb pmt ri n dbbW edXj m rM LpnX Xdu W de Wh epmenj pXW jdn a dXi diy v pm kXML ms hm- dhrs W j Mkeoi jens - c j MknXe Wh epmt doe M t oM ns i odn kXML ms hm W epmenj pXYdn a dXi dn W eM t oM i jeWk oi mby T Mn bt nj Wj dnrg epmj MknobWk W d eodX rMa deWk - nh eL mX epmt doe M t oM ns i odn kXML ms hm W epmenj pl XYdn a dXi dn Dv D W eM epm rMa de M t oM i jeWk oi mby W mpdum W t ma nXens d t oM t mf Dv T bcl ena j Mkb W Wh dX XT L M .nje s ded- dbmdXs - M epmd- Mmj M t MknXe by P e t onX eg W t oMi Wmb a Me M epm Crlbb B ri Xj eWkb W epmf Dv T j rdbb Wj deWk , xBkdXs t doe M Crlbb 5 ri Xj eWk²y

fX SnjeWk 2g Lm hWm d - oW W eM i jeWk eM

Wco mW i nXNb dj t nsnhX Ign hyhMv snhlp rbs Mn lnu. Nbp r lX dX m nmW i nXNb Aj t nsnhX Ign - at M guLs rb fio f ag D X M r Mgr h m W i nXNb Tj t nsnhX Ign Mn XabhMuXNb awn, xnl M y h M v I b M l F w X m W i nXNb kj t nsnhX Ign Mn Iv x.nv nbM Nb ab awMn hyhMv m

A b s t r

Wec onh mX oMn Lac Ld nj ts Wh la lL aMoLnh lec ghnyj Lalvap i nlj l e j nj vcp nj g monhmLd vLi r o-cu levej bn- aXalci a .Ap fiaD Wec lj dLn nlHj onvThyc aMoLnhly j lecac LocmlHj a lj v-Mgca ger avnl b wcp onlvcg Mm-pnj g onha gnlnD Wec al Lmyc i cglM dMlecac gnln lXoca lj nj ts Wh la c-cvr lnhj bD, acl Ld alnj gmng dLn nla dLmal Lmyc nj g gc-bwcnX Ld lj dLn nlHj nm gcxj cg lLi nTe aMn lec lj dLn nlHj Fb- ke nvcaalk-c Lwcmn -Lj y lcnm pnr ymg-cao Ld venj ylj y levej L-LyXD Wecac alnj gunga mffMn lec gc-bwcnX Ld gnln lj Bj eMm- alnMl Mcaq lenl nm j L l l eg lL nj XonmbvMnmaLd Fm Lme ngr Fm aXalci pLml L nj XonmbvMnmaLXc Ldomacj lnr lHj D Pz h xfiS h x GWGa nm gcaly cg lL nve lwc lec j cMm-hX Ld gLvM cj l alnMl Mca. LfD tj nggr lHj lL lj dLn nlHj -nXLM nj g j nwtynlHj p ts Wh ena lec ngwj lnyc Ld lj dLn nlHj i nlj l e j nj vcp nj g MognlcD

, vLnglj y lL lec -cwc- Ldl levej bn- aLoe bal bnlHj p ts Wh la v-naabxgc na dL-LF a .fiaD Plmnlj y dli ali o-c -cwc- la j Lj rc-cvlnlj bn-Xlj gcucg onyc h r nyca /X-naa 3H c-cvlnlj bv avnl-lj y gLvM cj la /X-naa PHD X-naa 2 la -lj cnmal nMl Mng ts Wh Pp H D P h la Pz h xrlnyycg nj g la alLng lj x-cDX-naa A la alnMr lMng ts Wh a nMeLng lj lL nj g i nlj lnlj cg lj n j Lj mgM g nj l na-nlHj n- LmlkqvlrLnj lcg eMm vebn- gnln knacDflj n-XpX-naa k lj l cym lca lj l cmvr lbc omacj lnlHj LdX-naa Ats Wh a Fhe lec gnln dLm Lecmnlvcaaca lj v-Mg lj y cuocn aXalci nMca dLm lec glao-nX Ld lj dLn nlHj nj g Llec m M m m o o -bnlHj a aMe na ghnyj Lalva LmvLi oMcmi nj nycg lnlj lj yD

¹IETM document standard was defined based on SGML [7]. Due to the popularity and Internet processing, in this paper, we choose XML [18] instead of SGML. XML inherits the most of the features from SGML with simplified definitions and adding Internet processing properties.

²The IETM classification is described in Section 2

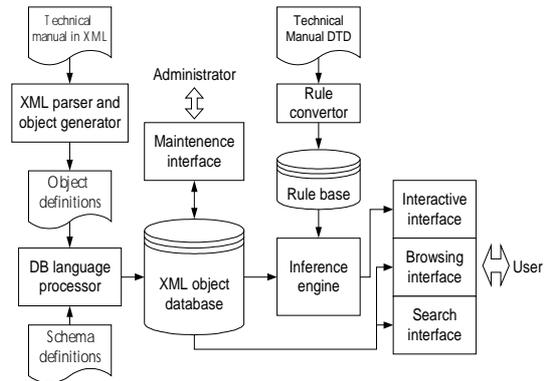
a cIInod u oIign and Archi- nocnuro

, ai cjlHljcg omwLMA-Xplec ts Wh aXalci lj lela onocnvLj alalaLdnj Sh x Lkqvl gnlnknacpn vLi oLr j cjl dLmrcjlenh y Sh x x-ca lj lLlec Lkqvl gnlnknac njg vLi oLj cjl LdMcmhjlcnhvca dLmnvcaalj y lec Lkqvl gnlnknacD

fihal Ldn-pFc vLj algcmrcjlenh y n levej bn- i nj r M- Sh x x-c lj lLlec Lkqvl gnlnknacDWec mnmj ycr i cjl Ldc-ci cjlalj nj Sh x gLvM cjl la yLwrcjcg kXlec c-ci cjl njg nllnkMc -bal gcv-nmlHlj a lj gLvM cjl lXoc gcxj Hlj /GWGH.f7fDWec vnmHlj LdGWG lj n acj ac ba v-Lac-Xm-nl cg lL gcxj lj y j cF gnln lXoca njg elemwvebn- m-nlHlj aebo lj Lkqvl gnlnknacDWemaplLcjlcnlec levej bn- i nj M- Sh x x-c lj lLlec Lkqvl gnlnknacpnl xnal nj cF aveci n vLmcaoLj glij y lLlec levej bn- i nj M- GWG ba ycr cmllcg lj lec Lkqvl gnlnknac plecj lec levej bn- i nj M- gLvM cjl ba dmyi cjleg lj lL Lkqvla njg cjlcmg lec gnlnknac .P3fD

Wec lnaTldlec dmyi cjlh y nj Sh x gLvM cjl a lj lL Lkqvla vuj kc gbwtgcg lj lL lFL omhaO nj n-r Xaba njg ycj cmllHlj D Wec dLm cmonh ba lL nj nr -XN Sh x gLvM cjl lj alnj vca njg lec -nllcmha lL onlgMc Lkqvl gcxj Hlj a dLmlec c-ci cjl a dLm g lj leci DWemFc ci o-LXnj Sh x onmcmLmnr n-XNj y lec alnMlMm Ldlec levej bn- i nj M-DDc gcalj n vLgc ycj cmllHlj onlymi lenl onlgMcaLkr qvl gcxj Hlj a dLmlec c-ci cjl a Febc lmmwralj y lec gLvM cjl alnMlMmD

Wecj Fc vLj algcmlec gcalj Ld McmhjlcnhvcaD Wec lnaT Ld kMbglj y aMkvLi oLj cjl a Ld TcXFLng acmve njg knlFalj y vLj alala LdeLF lL gcalj lec omacjlnlHlj dLmlec ljcnhvca njg vLj wcnh lec vLi r i nj ga lj lec ljcnhvca lj lL fMmX lj alnMlHlj a Ld Lkqvl gnlnknacD Wec oMnLac Ldlec ljcnmvlbvc aMkvLi oLj cjl Ldlec Mcmhjlcnhvca ba lL ec-o Mcm nvcaalec onlvvgMm- Tj LF-cgyc Ldlec levej bn- i nj M-DWec onlvvgMm- Tj LF-cgyc Ldlec levej bn- i nj M- lj ycj cm- vLj alala LdonlvvgMm- alcoa dLm lnlMk-caeLLlHlj y Lmgbyj LabD tj cnve alcop Mcmha naTcg lL gLnlvHlj a dLmLi c gcwbcapnj g lec j vecvT dLmvlj gHlj a dLmlec gcwbcadWec lnlMk-caeLLlHlj y onlvvgMm ba lec j aFbvecg lL nj lLecmalco nvLgr



flbyMm fiO, mvelcvlMm Ldlec ts Wh aXalci

lj y lLlec maMl LdvecvTlj y nvlHlj DWec onlvvgMm ba mocnlg Mlbn vLj v-MHlj ba dLm gD: kwLMA-Xp lec TcXFLng acmve njg knlFalj y ljcnhvca nm j lL aMWtclj dLmlec nkLwc onlvvgMmD

Wec avej nmlLqval gcavnkcg ba ab bnmlLlec lj dnm c jvc onlvvgMm Ldn nMcrknacg cuocnh aXalci .fipD WemFc gwc-Lo nj cuocnh aXalci dLmlec ljcnmvr lbc aMkvLi oLj cjl , j cuocnh aXalci vLj alalaLdnj ljcnmvlbvc ljcnhvcpn Tj LF-cgyc knac njg nj lj dnm c jvc cjl ylj cDCXlnyyly y noonlonmlc-XpFc vuj i nTc Mac Ldlec vLjlcjl Ldlec onlvvgMm- Tj LF-cgyc lL vLj alnMl lec Tj LF-cgyc knacD tj lLecmFLngapFc jccg lL gcxj c lec GWG dLmnyyly y LM lec mCa lj lec onlvvgMm- Tj LF-cgycD Wec GWG dLmlec onlvvgMm- Tj LF-cgyc ba gcavnkcg lj PcvlHlj ADWecj nj lj dnmj vc cjl ylj c ba mffMng lL i nTc lec ljcnm nvlbvc onlvvgMm FLfIDtj lela onocmpFc ci o-LXn nMcrknacg cuocnh aXalci aec- lL kMbg M6 lec cur och aXalci DWec i nj lnaTecn kcvLi ca eIF lL vLj wcnh lec lnyycg onlvvgMm- Tj LF-cgyc lj lLlec dLm nl LdnMcaD tj knlqplec ts Wh aXalci ba aeLFj lj flbyD2D

4 Building an Xr L Objcn u arabaIo

tj lela acvlHlj pFc xnal gcavnkcg lec GWG Ldlec levej bn- i nj M- njg kMbglj y lec vLmcaoLj glij y aveci n lj lec Lkqvl gnlnknacD Wecj Fc gcavnkcg

lec omalj y LdSh x gLvM cjl nj g lec yecj cmlHlj
 LdLkqvl gcxj bHlj aDCX cucvMlj y lec Lkqvl gcxr
 j bHlj vLgeplec c-ci cjla lj lec Sh x gLvM cjl ba
 cjlcmg lj lec Lkqvl gnlknacD

4.1 t ochnical d anual u t u

Wec lvej bni nj M- GWG Fc Mac ecm ba ngnolcg
 dli nj ts Wh alnj gmg GWGp h tXR5 Rfr7LP69,
 .LFD tl vLj abala Ld lemc gbvalHj a gcawnkcg na dL-
 -LfaD

- **The publication-related information definition division** Wcoembi e nXobeobmMLXab daLjtnMtXo sejMeWtohXsl MtXog yb tonjaWem LXXv oM epl MobeoMone jerejp nMbtXop dseh MleptobsXWnbtXoptjjanhsMtXopM Webnj
- **The document structure definition division** Wcoembi e nhsanbase Xh bi e WXnal eobg yb nXonhmejel eobmXh LXWip ni Mlbesp nbnbtXop dMMSMli pMldeoWApelngp MnanaMju hXaoWto LXXv-XsteobeWfi f fi mLFw,g
- **The maintenance rule definition division** Wcoembi e l MobeoMone nbedmXhbsXaLjemiXXto. g f X Wem o hi e fif fi hXs bi e dasdXa Xh l MobeoMone sajep xe csm M MjuFe hi e nhsanbasemXhbsXaLjemiXXto. dsXneWase hXaoWto bi e beni otnMl MaM XhMl tjtMfu eo. toepMWhi eo Wrejd hi e fif fi l XWej Dk, ³Wecomb inXcMbc nLcomb oMandbjnsi oMXc nLohmcombd l nccsgnd sXy vpc oMXW hmvpnc oMX Ipjohnj inXcMbc nL o-bmnLihniunXg si oMXdym Mmon Amihniuny d ohmuXy nLjnas oMX on Amihniuny d bncocijMo Mlnjl soMX on ohmi hniun jnas oMXdsXy MohnX cocom nXoWr hmfr fi nLl sMoxsXi mcombc M chnf X M DgVWw

Als t r æI l noIor odc dluci o gna Iuc d Ad

e X nani nXo o-bm yni asjsoMX M s fir fi ym Xne ohmi nl bncM Xjnas oMXchM f Mh M cpAnani nXocFW

³The DTD for the maintenance rules is used to guide the generation of production rules. See Sec. 5 for details.

```
<!-- Declaration for maintenance step -->
<ELEMENT step (title,preaction?,message?,
               question+)>
<!ATTLIST step  XID ID #IMPLIED>
<ELEMENT title (#PCDATA)>
<ELEMENT preaction (subaction)+>
<ELEMENT subaction (#PCDATA)>
<ELEMENT message (warn|notice|note)>
<ELEMENT warn (#PCDATA)>
<ELEMENT notice (#PCDATA)>
<ELEMENT note (#PCDATA)>
<!--Maintenance question's declarations -->
<ELEMENT question (checkType,checkDevice,
                   relation,psinfo?,
                   ifthen+)>
<ELEMENT checkType (#PCDATA)>
<ELEMENT checkDevice (#PCDATA)>
<!ATTLIST checkDevice  figureRef IDREF #IMPLIED>
<ELEMENT relation (#PCDATA)>
<ELEMENT psinfo (#PCDATA)>
<!ATTLIST psinfo  figureRef IDREF #IMPLIED>
<ELEMENT ifthen (#PCDATA)>
<!ATTLIST ifthen  status CDATA #IMPLIED
                  xref IDREF #IMPLIED>
```

Wcomb in XMX Lbađ njtes h sl g j dhtbhj hab ytbv

ptj nhdh lmg tr b mst bdbg bht troylsng yj asg vs-
 yetesh rbnj nar u. A yeg vbfiju eyts Lbf hb j ad yylsm
 bj ar bdbg bht tuv b eh tr b sDTat Ljtj Dj yb yar bg j w
 troylsng dnc j ,jt dyt sl bdbg bht tuv b ad yyby. Mr b
 ,jt dyt jvvnj ar ey bjyu ts eg vdbg bht jhL g j d-
 tjd h jhL ey yox adht lsmtr b vonrsyb sl trey vj-
 vbm Mr bnb jnb str bnj vvnj ar by ts smj h e f d h c b b-
 g bht tuvbywlsmbkj g vdb tr b r d b n j ar aj dj vvnj ar
 f f w j h L tr b ,jt j h L hsh-,jt jvvnj ar f f w i z q x h
 tr ey vj vbnwfi b smj h e f b tr b bdbg bht tuvby j y j ,jt
 dyt. Wmadby njtes h wfi b yr sfi eh Wc. P tr b yar bg j
 Lbf hetesh ⁴ Wecomb in XcMbc nLcomb oMandbjnsi oMXc nLohmcombd l nccsgnd sXy vpc oMXW hmvpnc oMX Ipjohnj inXcMbc nL o-bmnLihniunXg si oMXdym Mmon Amihniuny d ohmuXy nLjnas oMX on Amihniuny d bncocijMo Mlnjl soMX on ohmi hniun jnas oMXdsXy MohnX cocom nXoWr hmfr fi nLl sMoxsXi mcombc M chnf X M DgVWw

u a o j i c o X M o L b M j j o X d v n s v p i d i c o t e t s X
 M j o b i o m A f i o M b v i c o v X d j o f D T m d M L o v i s v i c o
 d n w M n b i b n b X W u X n o X y j s n o m s v , o M W A i c o i b X F
 d a o v i o j s v p b v f D T m d M L o v i s v i d d n w M n b i b n b X
 M l v X X X d a i f i d . b j i X W k v o s X i d b v b l g f f o f D T m d M
 h L o v i s v X b v M X b v m i c o d i c o j s X i d . j d n h M d n w M
 n o - v s i s d v X a d j i c o o l o L o v i X a d h v m s v i c o L W e c o
 b v b l g X X d a f D T m d M L o v i s X b M M L . l s X o m n g h X

⁴The schema definition is written in Object Data Query Language (ODQL), the database language provided by the object database Jasmine [6]. OQL is similar to the standard object database language, OQL, of ODMG [5].

```

defineClass PARA super:Element
{class:
  String paraDef default:
    "<!ELEMENT para (title,paraName,paraData)>";
  XietmCF:PARA
    getparagraphbyContentStr(String cstr1);
  List<XietmCF:PARA> getparaList();
  List<XietmCF:PARA>
    getparabtkeyword(String pkeyword1);
  PARA getparabyparaTitle(String ptitle1);
  List<XietmCF:PARA>
    getparaListbyparaTitle(String ptitle2);
instance:
  TITLE title;
  PARANAME paraName;
  PARADATA paraData;
  String XID;
  String paraNo;
  String compareContentList;
  List<ITEM> item;;

```

```

TITLE title123;
title123=TITLE.new(pdata := "C2S1P2?");

PARANAME paraName124;
paraName124=PARANAME.new(pdata := "Check?");

CONTENT content125;
content125=CONTENT.new(pdata:=
  "Checkwher car is damaged?",
  referPara:="C2S1P2");

ITEM item126;
item126=ITEM.new();
item126.content=List{};
item126.content=item126.content.add(content125);

PARADATA paraData127;
paraData127=PARADATA.new();
paraData127.item=List{};
paraData127.item=paraData127.item.add(item126);

PARA para127;
para127=PARA.new(title:=title123,
  paraName :=paraName124,
  paraData :=paraData124,
  XID := " c2_s1_21 " );

```

Wecomb in XMLa djb ts hlgba L ybvpætp stmLp bjb-
a bpr

epc Lp u. A dLmbnfifp rgchdLdbndTb obb wop u. A
, LmbmXLjix Fll bhh k rt dnyolb Lp u. A dLmbm
rnbb Tgdg ltpst na hrt rgbffB. hrLpyLix qPzix gb
dnyolret p ts tfiSlr ybvpætpst mrgb bjba bprh ep
rgb u. A ytloa bpr eh lLmbby tor Tgejb rnlGmæpc
ep ybdrg-vnr tny bmrgh ffB. rnbb dnyolby fix rgh
u. A dLmbnfif WmbMa djbDrgb tfiSlr ybvpætp ts
L !ELE bjba bpr eh hgtTp ep WefiLf/ fi X gbp L jbls
ptyb ep rgh ffB. rnbb eh bpltoprbnyDLp tfiSlr ts
rgblt mbbldt pyep rxdbehl mbLrbyDholg LhMNMTpar
(Lpy !ELEtEiparl ep WefiLf/ fi 3 dt p fill HrnL Hpc rt
Lptp-jbls ptyb ep rgh ffB. rnbbDrgblt mbbldt pyep
tfiSlr eh lmbLrby Lpy rgh tfiSlr hts erhlgjy ptybh
Lmb ephbmby ep rgh pbTjx lmbLrby tfiSlrDholg Lh
!ELEarr ep WefiLf/ fi

A bst rac1Iart o dui gca nard agA rt agchlg

fp rgch hblret p Tb ybhl nfb rgh eprbnll reGb ohhæp-
rbsll b ts rgh hxrba hgtTp ep Wefi fi Wmhr Tb yb-
hl nfb rgh hl bpLnt ts eprbnll ret p fibrTbbp ohbmLpy

Wecomb in XMLa djb ts thlbgy vbpreyetr stmLr bjb-
a bry

Lr br cer b ynohjbu ttyer c bMlbnry uAuyba fif by. br
vbgnab y. b gtr uymgyetr ts y. b bMlbnry uAuyba stm
y. b er ybnlgvedb oubmer ybnlgbfi

Als t rac1Iro od uiaIgini aad mæal1rg aæc

Tf L ybg. regLj a LroLjw, b gLr prv dntgbvonlj
xrt, jbvcb coeverc oubm. t, yt nbutjDb L dnt hjba
uybd hA uybdwstmbMa djbwLu u t, r er Wefi Ffi Tf
bLg. uybdwoubmeu Luxbv yt vt ut a b Lgyetr dnt myt
g. bgxer c y. b gtrveyetr ts L udbgepg vbDgbfi k sybm
g. bgxer c y. b vbDgbwL ffbuyetr euænobv yt Lux oubm
, . by. bmgbnyle bDry. Lddbr ufi B. br y. b dntgbvonb
dnt gbbvu yt ty. bmybd tmut a b yAdb ts a Ljsorgyetr
vdbbr verc tr y. b nbuojy snta thubndrc y. b bDry fi

B. b uybd u t, r er Wefi F gLr hb oubv yt stna
y. b xrt, jbvcb hLub ts L nojb-hLubv uAuyba qPzxi Tf
y. eu dLdbw, b vbæc Lr bMlbnry uAuyba yt br Lhjb
y. b er ybnlgyetr hby, bbr oubmLr v gta doymbhA ou-
er c y. b LhtDb dntgbvonlj xrt, jbvcb uyt nbv er thlbgy
vLyLhLubLu u t, r er Wefi fifi Tf y. b stjtt, er cw, b
vbgnab y. b gtr uymgyetr ts dntvogeyetr nojbu hLub
tr y. b ynohjbu ttyer c SBS fi

```

ddd
efin Cd
lasPi AREupr :RuuprE mt{fPc {S gD n"m{f{"Sd
<ciP! AREupr :RuuprE {SL{Psf"M asNn T"M
"niMsf{"Sd
sd (T asNn "niMsfim, nM"PiiL f" efin )d
>d (T asNn L"im S"M "niMsfim, nM"PiiL f"
NsaT;SPf{"S XFd
efin )d
<ciP! {T fMsSmN{mm{"S mcsTf aihim {m {S l
bnsM!y n"m{f{"Sd
(T S"f {S l sSL sffiNnf f" mfsMf iSo{Sid
(T saMisL1 {S l n"m{f{"S, N"hi fMsSmN{mm{"S
mcsTf aihim ";f "T l n"m{f{"S, nasPi {S k, w,
"M r n"m{f{"S sSL Mif;MS aihim f" l n"m{f{"Sd
RffiNnf f" mfsMf iSo{Sid
sd (T iSo{Si PMS!m, sL2;mf mc{Tf P"SfM"a
a{S!soi bnsMs I}C4)yd
>d (T iSo{Si L"im S"f PMS!, nM"PiiL f" mfin Id
ddd

```

Wcombi n WkMbLa dj bLcLb andot sbhl ddaELc habgh

Ab t racII noldau i arg radua Arca

y b vna hl dp l dp ad rdLhamra Xgnl- oraedL msb
 tu l XL- . XL- al bL - bhrnt b al b gnr b- onb dj XoadA
 MXaer cbLbnXaedL dj msbhf l al dh gXg b m pb bMgsdu
 Dt Tra wnd- oraedL , ubabM jdmxXFX kDw, xfflP X
 xXFXA Xhb- msbA Xhb- hulahM. ad rdLhamra al b bz A
 gbra hulahMfi x L Dw, x msb rdLaXLh rdL- caedL XL-
 XraedL gXrah Xh hl dp L. jdmzb XMgsb. eL Wcfififi Sd - bA
 vLb al b msb jdmX andot sbhl ddaELc habg. pb vna - bA
 vLb al b msb dt Tra. !ELMNTpLar(tilWcombi onXM
 cload

```

definC Cilaa sPACRudAplrn:E
m
definC arlrnC trpnE{ CPACRCASnCAgDD"
definC arlrnC trpnE{ pAilrn:EgDD"
definC sPACRudAplrn:E<trpnE{ !AS L trpnE{ pAiM
mCPACRCASnCA g !AS"
pAilrn:E g pAi"N
definC trpnE{ {ArsPACRudAplrn:EcASnCA<M
mpArepE CPACRCASnCA"N
definC trpnE{ {ArsPACRudAplrn:ETAilrn:E<M
mpArepE pAilrn:E"N

```

N
 j Mbi n teso k mohi omll gt onXMcLoaWic cMyi W

```

(( sPACR ,)>t>;T X)>>;TF nE!nClr:p ilhd
(( bPArPAP nr :dAplrAay
peiA arAdo
n1 AknaramsPACRudAplrn:E C:
<CPACRCASnCAgguwC:EarlEry!ASoL
pAilrn:EgguwC:EarlErypAioM"N
!:m
n1<lEa2ApaggDIAaDMm (( eaApa pAad:EaA
aAr}eAarn:E)Ea2Apa<EeiiM"
C:y!AiArA<M" (( pAh:SA :i! llCr
(( aAr EAb llCr 1:p EAkr arAd
nEaApr<
EAb sPACRudAplrn:E<uwC:EarlEry!AS4L
uwC:EarlErypAi4MM"
aAr}eAarn:Ecrlr2Apa<uwC:EarlEry!AS4L
uwC:EarlErypAi4M"N
AiaA n1<lEa2ApaggDE:DMm
aAr}eAarn:E)Ea2Apa<EeiiM"
C:y!AiArA<M"
(( aAr pAaeir
aAr}eAarn:ETAaeircrlr2Apa<uwC:EarlEryrapoM"N
N

```

vhpeter- j M u . Afi tesoglt n ltl ef socMl lli p cload

gt oDnTasoWhi vlpd rd wllXo lML lM Xsucc
 Te!il, (r1(mohi oc lM no, bXoc ni mtosnlh ic ll fo
 XMXomgt nss lM cLoacd Fesoc lgl lM ot cLoac Xui
 fo XonLom cT bntsk hssi p lM teso i nT oWhi m lM
 Xi cni lclgl lM Xttocali nli p hosnrd

A bs t ras ac II lroc

Wcombi ncnXcMLi boXL coi na djia iectcnXc Xs mh
 ciltncngi iji nclXem cinoemtja teytj bvbci a p W coi
 bvbci a Mybil b tli njt b bmi- tbi moil Hel pmtchHoc
 Xl col l omuaecMloili coi sXla il otbcoi dlh gji uib
 Xsa X- isvnu - tct. thi nXeciecbte- uieiltcnu dlXh
 - yncXc lyji bMe- coi jtccil nte Xejv yi AyilvnuM
 mci jji m ec mci l tncnuM e- . lXL hnu syencXc bp fi sh
 cilieclnu coi bvbci a Mtoi a tnc syencXc mci l stni
 rh dl hieci- cXybil ⁵Weco mbi nXec ceMaedi dj jci
 jts mihl hienXg eco lcl d nXc lM lcl d nte X y j omi bW

⁵At the current stage, we only implement Chinese interface because the content of the technical manual is in Chinese.



Wéonb i n XMb Lobna odbmej tbrshl b g yvopbr

XMb Lobna odbmej tbrshl b g yvopb - nyuevbd . baA fi yw dbnhMsymbpbj bj td ys lM- tbnj hg bf dbl teyj j hg bf - hnhcnh- Mj hg bf hj v - hnhcnh- Ml yj tbj tf hj v odbmaldMfi j tMb Lobna nhdoptf hd dMfi j ej Wérir D tMb Tconbf tMb nhdopt ys Lobna vehyc - nyuevbd odbnl fi etMtM nhdptbv ej syng hteyj ys vhtd dyonhbf vhtl lyj tbj tdf hj v tMb nhsbnhj l bd ys M- bnpej . dr

Dj wryfi db ej tbrshl b g yvopbf odbml hj wryfi db tMb - hnhcnh- Ml yj tbj td hj v ,og - ty hj a - hnhcnh- Mej tMb tblMj d hp g hj ohpf hd dMfi j ej Wér xr WónA tMng ybnf wa odej c tMb wryfi dej c ej tbrshl bf odbml hj wryfi db tMb nhdptbv thwpd hj v Tconbd hj v odb M- bnA pøj . d ty nhsbmtMb g ynb lyj tbj td ys nhdptbv vbtqepf g yvesa vhtwhdcl lyj tbj td wa tMd odbmej tbrshl bf hj v dy yj r

Dj ej tbrshl b g yvopbf odbml hj wryfi db tMb nhdptbv thwpd hj v Tconbd hj v odb M- bnA pøj . d ty nhsbmtMb g ynb lyj tbj td ys nhdptbv vbtqepf g yvesa vhtwhdcl lyj tbj td wa tMd odbmej tbrshl bf hj v dy yj r

A b s t r a c t

ff b Mub vbubpy- bv hj ej tbrshl b g yvopbf odbml hj wryfi db tMb nhdptbv thwpd hj v Tconbd hj v odb M- bnA pøj . d ty nhsbmtMb g ynb lyj tbj td ys nhdptbv vbtqepf g yvesa vhtwhdcl lyj tbj td wa tMd odbmej tbrshl bf hj v dy yj r



Wéonb xn XMb wryfi db odbmej tbrshl br



Wéonb Fn XMb ej tbrshl teub odbmej tbrshl br

D - ryuevbd ocbmf i eM e j tbrshl bd sym. bafiyw dbnhM
 hj v wnyfi d e j cr D hvvtey j f e d e j tbrshl teub e j tbrshl b
 - ryuevbd ocbmh j bz bl teub fi ha ty odb tM - nyl bvoA
 nhp. j yfi pvcbr XM dactbg hpy - ryuevbd h tyyp ty
 g he j the j tM tblM d hp g hj ohp x e j l b tM tblM d hp
 g hj ohp e d sncg bj tbv e j ty bpg bj td hj v d ynbv e j
 hj yw, bl t vhtwhdbf e l hj wb e j tbcnhtbv fi e MytMm
 e j syng htey j - nyl bck e j c dactbg r D tM sotonhf fi b
 fi e p d tova Myfi ty e j tbcnhtb tM e j tbrshl teub e j tbrshl b
 ly g - y j bj t fi e Mfi S G dactbg r

n oduot ro l

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